Instruction Manual

3M

500DL
Precision Cable Locator
Operators Manual

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Telecom Systems Group

Dynatel™ 500DL
Precision Cable Locator

Operators Manual

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Description and Specifications

1. General

1.1 This manual covers the description, use, care, and maintenance of the Dynatel 500DL Precision Cable Locator (refer to Fig. 1–1). The 500DL is a portable instrument which locates the path of buried cables. Four frequencies are available to accommodate varying factors such as distance, cable type, or soil conditions. A separate tone function in the Transmitter provides a powerful 577.5 Hz signal for identification using a separate toning amplifier. The instrument is also able to detect 60 Hz AC power signals. In the depth measurement mode, the 500DL provides a direct digital readout of the estimated depth of buried cables, and a bar graph indication of the relative current in the cable.

2. Description

2.1 The 500DL Precision Cable Locator and accessories are shown below. Refer to the list of standard and optional accessories in Table 1.

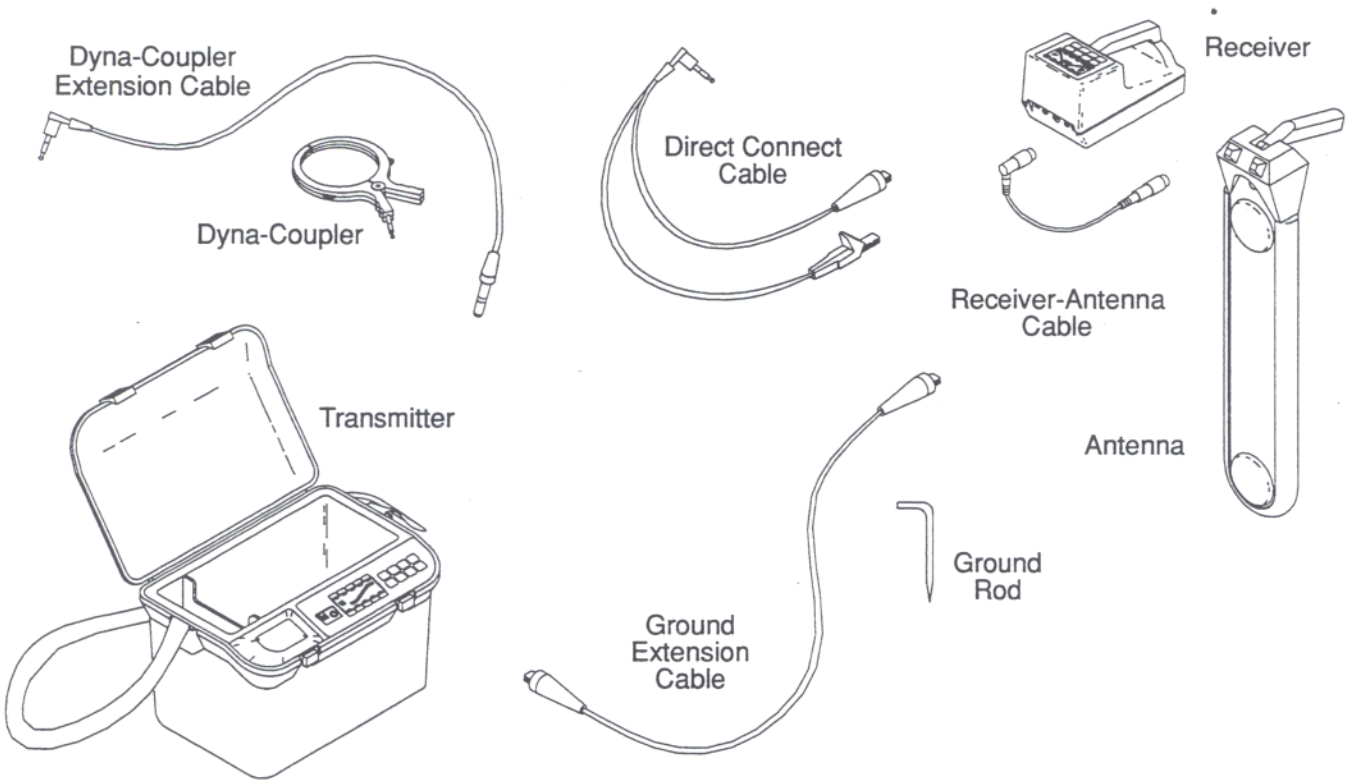

Fig. 1–1 Dynatel™ 500DL Cable Fault Locator

Table 1
Accessories

STANDARD ACCESSORIES	OPTIONAL ACCESSORIES *(not shown)*
Direct Connect Cable	1-inch Dyna-Coupler
Ground Rod	6-inch Dyna-Coupler
Ground Extension Cable	Inductive Probe
Short Receiver-Antenna Cable	Battery Charger Kit
Dyna-Coupler Extension Cable	Nickel-Cadmium Rechargeable Batteries
3-inch Dyna-Coupler	Receiver-Antenna Scabbard
Alkaline Batteries *(not shown)*	Receiver Carrying Strap
	Long Receiver-Antenna Cable

A. Transmitter

2.2 The Transmitter is in the unit's case with a control panel, battery compartment, and a storage compartment for the Receiver and some accessories.

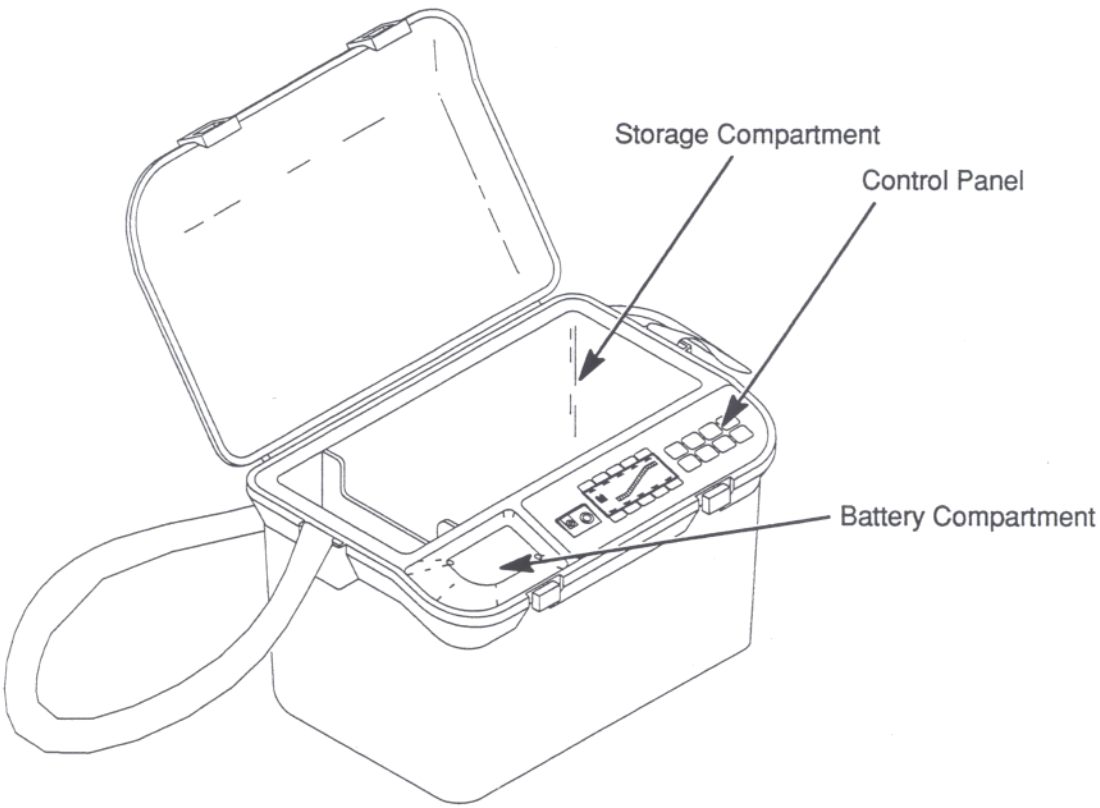

Fig. 1–2 Transmitter

2.3 All controls and connections are accessible when the Transmitter case lid is open. Refer to Fig. 1–3 for the control panel layout. The circled numbers are described in the following text.

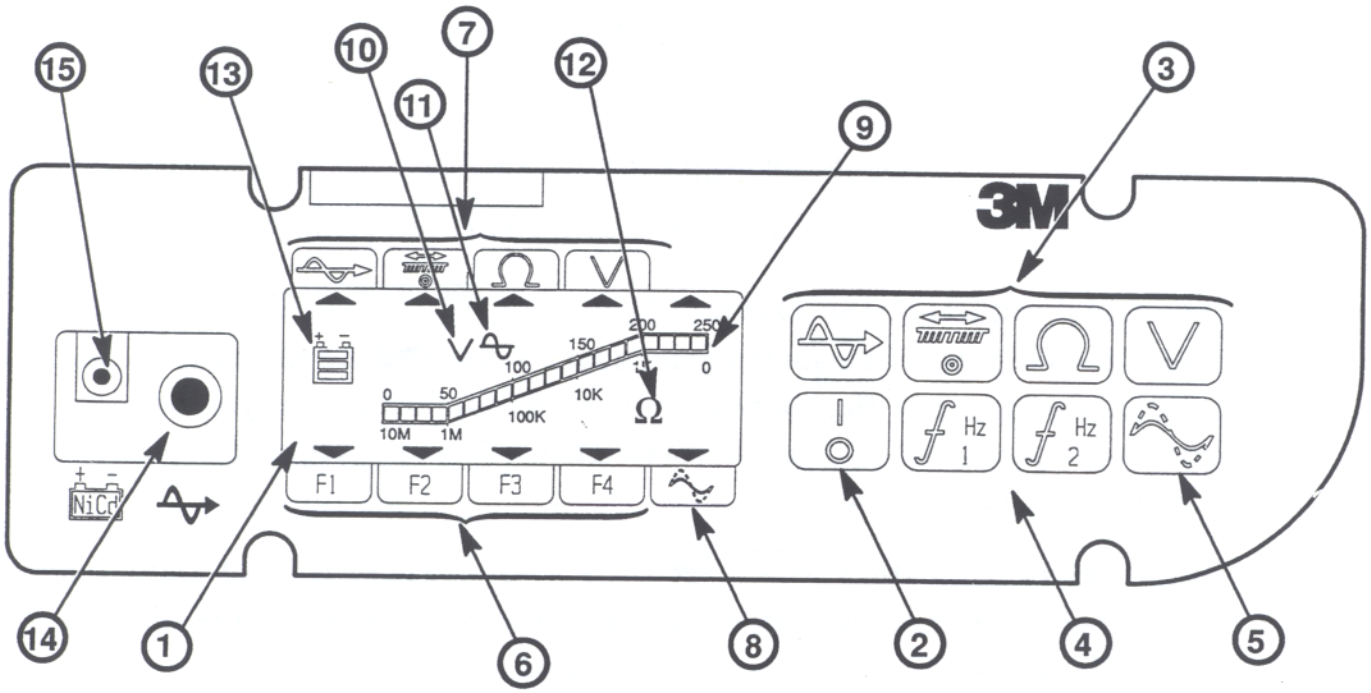

Fig. 1–3 Transmitter Control Panel

① **Liquid Crystal Display (LCD):** The LCD provides visual indications about the mode of operation, Frequency, Voltage and Ohms measurements, output level, and battery status.

② **On/Off Key** [I/O]**:** Turns Transmitter power on or off, when pressed. The Transmitter defaults to the [V] (volts) mode when power is first turned on. The Transmitter beeps every four seconds when power is on.

③ **Mode Select Keys**: Allow you to select one of the four modes of operation;

- Tone [~],
- Trace [≡],
- Ohms measurements [Ω], and
- Voltage measurements [V].

④ **Frequency 1 (f Hz 1) and Frequency 2 (f Hz 2) Keys:** Used to select the frequency of the tracing signals. Press these keys to step the Transmitter through four possible selections. In [trace] (trace) mode, you can apply two frequencies to the conductor simultaneously; the first being selected by [f Hz 1] and the second by [f Hz 2]. In [tone] (tone) mode, [f Hz 1] is inoperative, but pressing [f Hz 2] causes the 577.5 Hz tone to become interrupted.

⑤ **Output Level Key [output]:** Used to alternately select either high or normal output power. This key functions in [trace] (trace) or [tone] (tone) modes.

⑥ **Selected Frequency Indicators [F1] [F2] [F3] [F4]:** These legends show the four possible frequency selections. A flag (▼) appears above the selected frequency. A flashing (on and off) flag indicates that you have selected a frequency which is not allowed (such as the low frequency when using the induction method).

⑦ **Mode Select Indicators [tone] [trace] [Ω] [V]:** These legends show the four possible modes of operation. A flag (▲) appears below the selected mode. You can select only one mode at a time.

⑧ **Output Level Indicator [output]:** If you select high power output, the LCD flag above the legend is visible. Otherwise, normal power output is selected.

⑨ **Bar Graph Indicator:** A twenty-segment bar with numeric legends above and below. In [trace] (trace) or [tone] (tone) modes, the upper and lower numeric legends are not visible and the bar graph indicates the relative magnitude of the Transmitter signal. In [Ω] (ohms) mode, the lower numeric legend is visible and the bar graph reads resistance. In [V] (volts) mode, only the upper numeric legend is visible and the bar graph reads either AC or DC volts.

⑩ **Voltmeter Mode Symbol V:** This symbol is visible when the bar graph displays measured voltage.

⑪ **Output Mode Symbol ∿:** This indicator is visible when the bar graph displays relative output signal level.

⑫ **Ohmmeter Mode Symbol Ω:** This indicator is visible when the bar graph displays measured resistance.

⑬ **Battery Level Indicator** : This symbol contains three horizontal bars that indicate relative remaining capacity of the batteries. If all three bars are visible the batteries are good. When the two lower bars are visible, alkaline batteries are good but Ni-Cd batteries are starting to get low. When only the lower bar is visible, alkaline batteries are getting low but they will probably finish the job. Ni-Cd batteries are low and should be used only on short jobs. They should be re-charged soon. If no bars are visible, Ni-Cd batteries need to be charged and alkaline batteries need to be replaced. The battery level indicator is continuously displayed.

⑭ **Input/Output Jack** : Input and output signals are connected here using the Direct Connect Cable or a Dyna-Coupler Extension Cable. In Ω (ohms) or V (volts) modes, the measurement is made through the Direct Connect Cable plugged into this jack. With the plug removed and the Transmitter in TRACE (trace) mode, the internal induction coil is energized.

⑮ **Battery Charger Jack** NiCd: The external battery charging accessory is connected to the Transmitter through this jack. The Transmitter may be operated from 12 VDC supplied by an automotive battery. The voltage is applied to the Transmitter through the battery charger jack using the 12-volt automobile adapters (refer to Section 6, para. 1.7).

B. Receiver

2.4 The Receiver operates with the antenna either attached or detached as in Fig. 1–5.

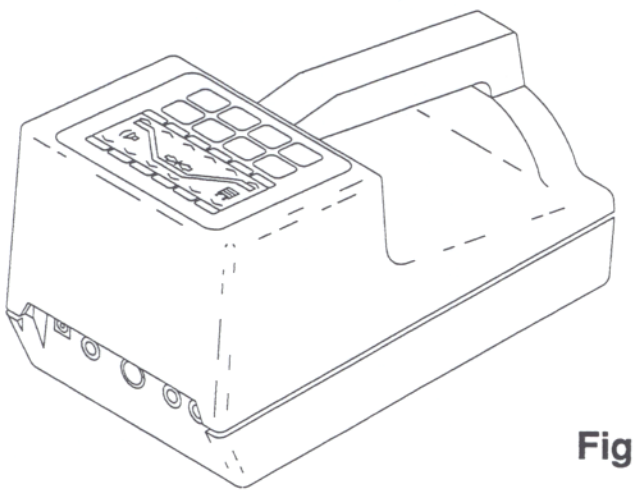

Fig. 1–4 Receiver

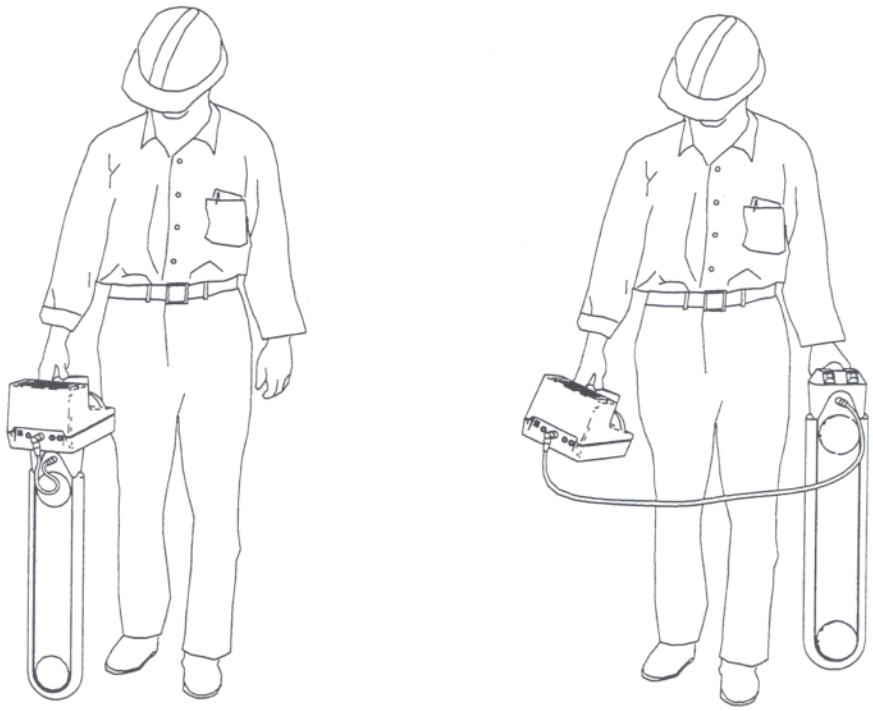

Fig. 1–5 Receiver-Antenna Configurations

2.5 To attach the antenna to the Receiver, place the top of the antenna in the cavity on the bottom of the Receiver. Snap the handle down flush with the blade of the antenna to lock the antenna and the Receiver together. Use the folding handle to direct the antenna when using it separately from the Receiver.

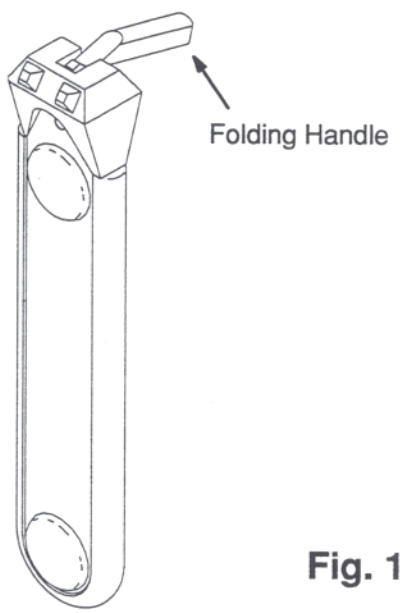

Fig. 1–6 Antenna

2.6 On the front of the Receiver is a connector panel with four jacks (refer to Fig. 1–7).

The large jack (marked ANT) is an eight-pin DIN connector for the antenna. Two cables are available for connection to this jack; use the short one when the antenna is mounted to the Receiver and the optional long one when the antenna is used separately. Both cables have a right angle plug on one end that attaches to the Receiver. The other jacks on the connector panel are clearly marked and include:

Battery Charger jack (use only when charging re-chargeable batteries),

Headset jack (when using headphones instead of the Receiver's internal speaker), and

Coupler/Probe jack (for inductive couplers such as a Dyna-Coupler or optional inductive tone probe).

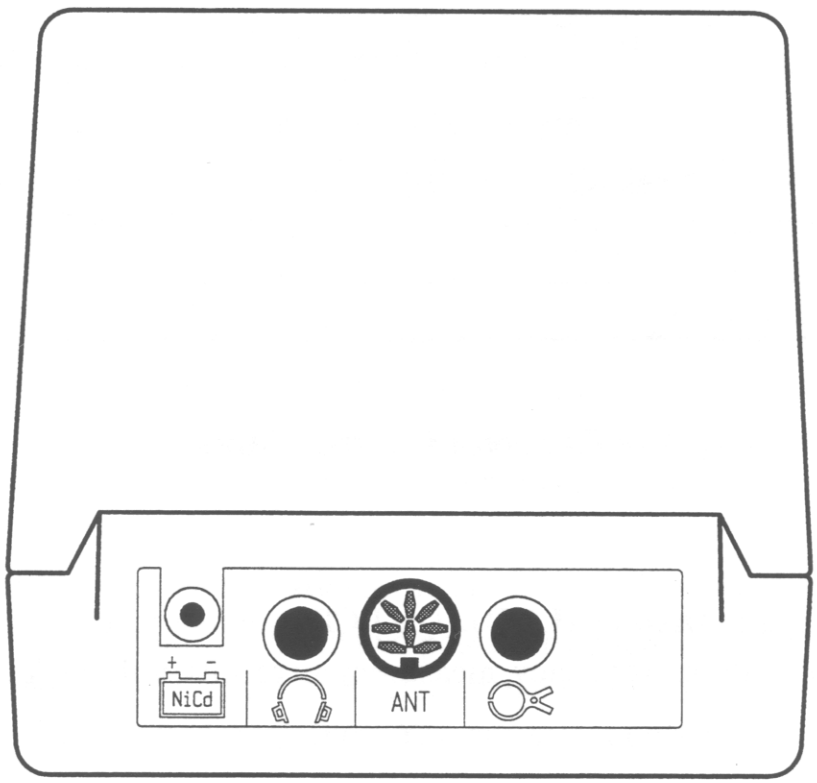

Fig. 1–7 Receiver Jack Panel

2.7 The Receiver control panel is located in front of the handle. Refer to Fig. 1–8 for the control panel layout. The squared numbers are described in the following text.

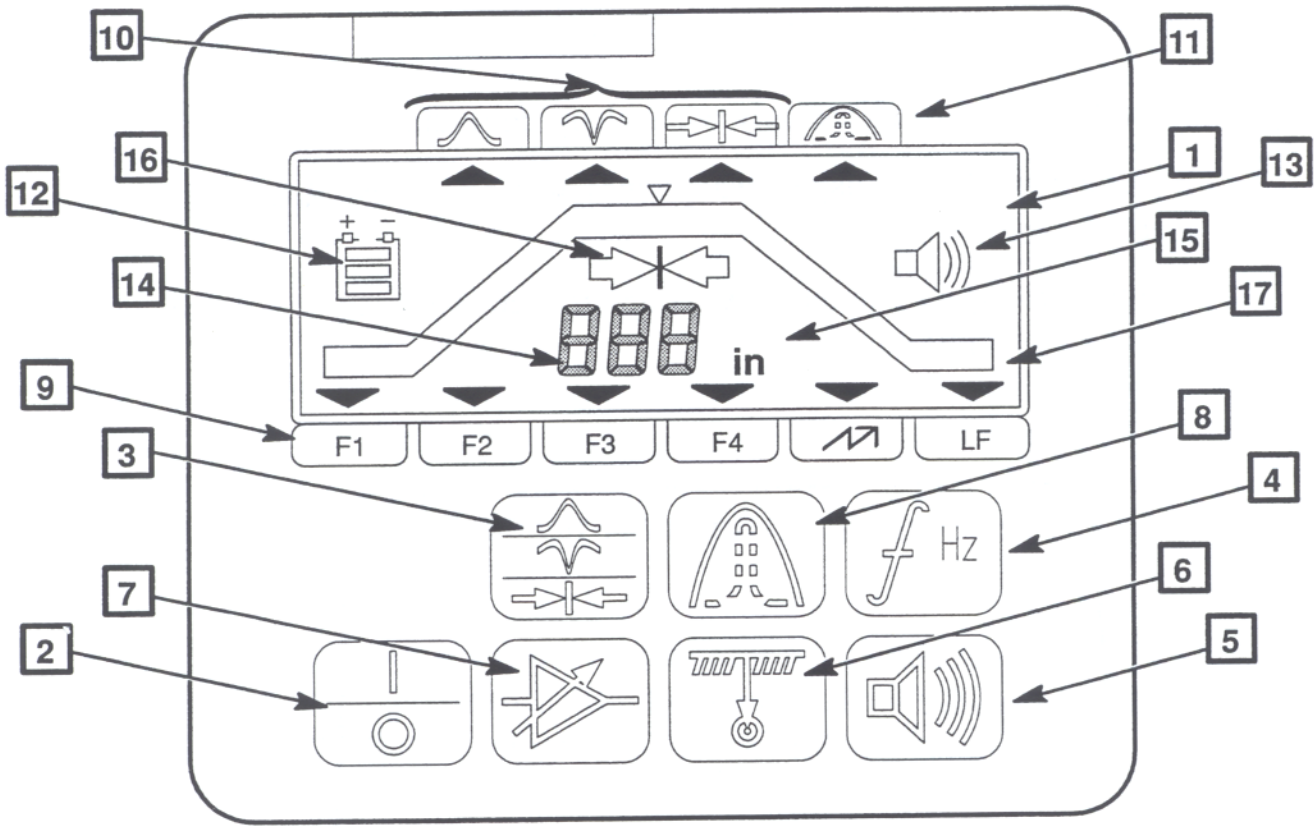

Fig. 1–8 Receiver Control Panel

1 **Liquid Crystal Display (LCD):** The LCD provides visual indications about mode of operation, frequency, measurement results, volume level and battery status.

2 **On/Off Key** ⏻**:** Turns Receiver power on or off when pressed. Any user-selected modes, frequencies, or functions are saved when power is turned off and is the same when power is turned on. The Receiver automatically turns itself off after 30 minutes if no keys are pressed or connections made to the connector panel.

3 **Trace Mode Select Key**: Used to trace a buried conductor in one of three modes: (peak), (null), or (differential).

4 **Frequency Key**: Used in either peak, null, or differential selections of (trace) mode to select one of the four active frequencies or one of the two passive frequencies. Each keypress advances to the next sequential frequency.

5 **Volume Key**: Used to sequentially select one of the four speaker audio levels; off, low, medium, or high.

6 **Depth Key**: Used to obtain a depth measurement to a buried cable. This key enables and disables depth and current calculations.

7 **Gain Adjust Key**: In (peak) or (null) modes, pressing this key adjusts the sensitivity of the Receiver either up or down to maintain a satisfactory signal level. In the (differential) mode, the unit automatically adjusts its sensitivity and this key does not function.

8 **Expander Key**: In (peak), (null), or (differential) modes, this key enables or disables the (expander) function. The (expander) makes peaks or nulls more pronounced and enhances the amplitude difference between two conductors carrying the same tone.

9 **Selected Frequency Indicators:** These legends show the four active (F1, F2, F3 and F4) and two passive frequencies (power and LF low frequency) that you can select in the trace modes. A flag ( ) appears above the selected frequency. You can select only one frequency at a time.

10 **Mode Select Indicators**: These legends show the three possible modes of operation, in order shown: (peak), (null), and (differential). A flag ( ) appears below the selected mode. You can select only one mode at a time.

11 **Expander Select Indicator** : When the LCD flag below this legend is visible, the expander function is on.

12 **Battery Level Indicator** : This symbol contains three horizontal bars that indicate relative remaining capacity of the batteries. If all three bars are visible the batteries are good. When the two lower bars are visible, alkaline batteries are good but Ni-Cd batteries are starting to get low. When only the lower bar is visible alkaline batteries are getting low but will probably finish the job. Ni-Cd batteries are low and should be used only on short jobs. They should be re-charged soon. If no bars are visible, Ni-Cd batteries need to be charged and alkaline batteries need to be replaced. The battery level indicator is continuously displayed.

13 **Audio Level Indicator** : When the speaker symbol with arcs representing sound waves is visible, audio is selected. The number of 'sound waves' in front of the speaker indicate the level is set to low, medium or high.

14 **Numeric Display:** The three-digit numeric display continuously displays the relative received signal strength in all modes unless (depth) is pressed. Then depth to the buried cable is displayed in feet and inches.

15 **Depth Measurement Units:** The 'in' (inches) indicator is visible only during depth display.

16 **Left-Right indicators** : These indicators are visible only in (differential) mode. In this mode, the arrows point toward the cable.

17 **Bar Graph Indicator:** This indicator shows the nearness to a position directly over a buried conductor. The method of indication depends on the mode of operation.

a. **Trace Modes** (peak, null, or differential): When the antenna is directly over the buried conductor, all or nearly all (depending on the signal strength) of the segments of the bar graph are visible. When the antenna is either right or left of the conductor path, the bar graph begins to separate at the middle. As the antenna is moved farther from the cable, fewer and fewer of the middle segments are visible (refer to Fig. 1–9).

b. **Current Measurement**: The bar graph indicates the magnitude of tone current in the buried conductor. When you press (depth) over a conductor with a relatively high current, all or nearly all of the segments of the bar graph are visible. Conductors with less current cause the bar graph to separate at the middle. This feature is useful when two nearby conductors are both carrying tone. The conductor with the greatest current is easily identified.

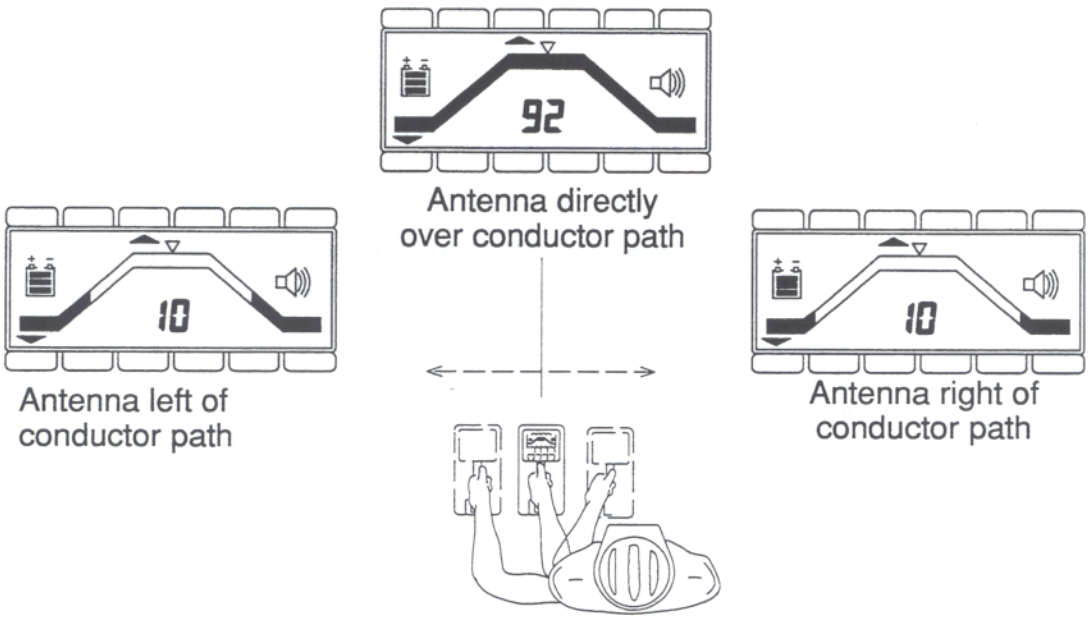

Fig. 1–9 Bar Graphs in Trace Modes

3. Specifications

Transmitter Specifications

Modes of operation
Single: trace or tone
Multiple: two trace frequencies

Signal application method
External: using direct connect cable, or Dyna-Coupler
Internal: using internal induction coil

Signal level control
Automatic signal level control selectable between normal or high

Trace frequency
One of four preprogrammed user-selectable frequencies.

Tone frequency
Preprogrammed to 577.5 Hz

Output signal characteristics

Frequency:
F1 – 577.5 Hz
F2 – 8 kHz,
F3 – 33 kHz
F4 – 200 kHz

Voltage: Trace mode . . . . . 0 to 25 Vrms

Current:	**Trace**	**Tone**
NORM.*	10 mA (max)	3 mA (max)
HIGH.**	100 mA (max)	25 mA (max)

* Limited to 0.5 watts out.
** Limited to 2 watts out for frequencies < 45 kHz or 1 watt for frequencies ≥ 45 kHz.
Output level is displayed as a relative measure.

Volts function
0 to 250V average AC & DC voltage on the line.

Display resolution 12.5V
Maximum error: for 120 VAC RMS . . . (–2.7 ± 4.5)V
for 48 VDC . . . . . (4.1 ± 3.9)V

Ohms function
0 to 10 Meg Ohm, logarithmic indication with each decade linearly divided into 4 segments

Battery
Six Ni-Cd or Alkaline D cells

Typical battery life:
Ni-Cds . . . . . 30 hours between charges
Alkaline . . . . . 110 hours

Charger
11 to 15 VDC input at 450 mA. 15-hour charge cycle from fully discharged.

Temperature

Operating	–4° F (–20° C) to 122° F (50° C)
Storage	–4° F (–20° C) to 122° F (50° C)
Charging	50° F (10° C) to 104° F (40° C)

Receiver Specifications

Frequency

	Active	Passive
F1 –	577.5 Hz	540 Hz (↗↗)
F2 –	8 kHz	512 Hz (LF)
F3 –	33 kHz	
F4 –	200 kHz	

Sensitivity, Coupler/Probe jack

Maximum open circuit input voltage from 50 ohm source to obtain audio signal plus noise-to-noise ratio of 6 dB:

6–25 kHz	0.3 µV
25–200 kHz	0.5 µV

Depth

inches option:

Range	0 to 100 inches
Accuracy	± 10% of reading for 2 to 60 inches or ± 1 inch, whichever is greater. ± 15% of reading for 60 to 100 inches

Battery

Five Ni-Cd or Alkaline C cells
Typical battery life:

Ni-Cds	20 hours between charges
Alkaline	50 hours

Charger

11 to 15 VDC input at 450 mA. 15-hour charge cycle from fully discharged.

Audio

Internal speaker or external headphones.

Temperature

Operating	–4° F (–20° C) to 122° F (50° C)
Storage	–4° F (–20° C) to 122° F (50° C)
Charging	50° F (10° C) to 104° F (40° C)

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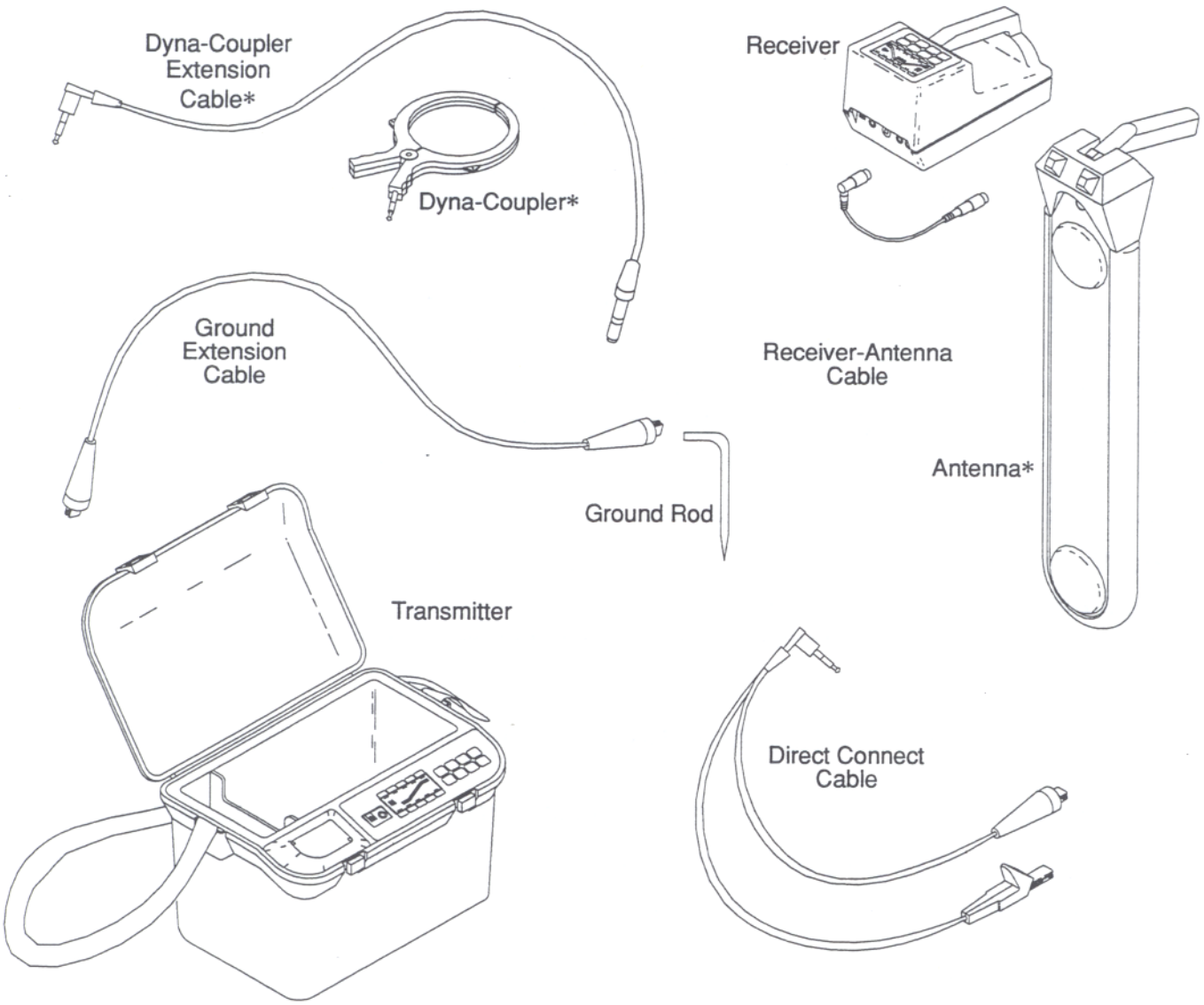
Getting Started

1. Tracing

1.1 Tracing buried cables requires these components:



* *Optional for tracing*

Fig. 2–1 Tracing Equipment

A. Connecting the Transmitter

1.2 Use one of the three methods below to put tracing tone on a cable.

Direct Connect Method

1.3 The Direct Connect method requires access to the cable shield. It is best to remove the ground bonding at the near-end. Do not remove the ground bonding at the far-end. Follow these instructions to use the Direct Connect method. Refer to Fig. 2–2.

> ***CAUTION***
> *Make all direct test connections before turning on the Transmitter. Then activate the Transmitter and check the display for voltage readings. Voltage higher than 130 volts will damage equipment. Follow standard procedures for reducing the voltage.*

a. Make sure the Transmitter is off. Plug the Direct Connect Transmitter Cable into ⇝ (input/output) jack. Connect the Black clip to the ground rod. Place the ground rod in the earth perpendicular to the suspected cable path. If necessary, extended the ground lead with the Ground Extension Cable.

> ***Note:*** *Never ground to water pipe or other services in the area. The return signal through these services may mislead the trace.*

b. Attach the Red clip of the Direct Connect Transmitter Cable to the shield.

c. Press the Transmitter [I/O] to turn the Transmitter on. The Transmitter activates in the [V] (volts) mode and beeps every four seconds. Watch the bar graph on the Transmitter display for any voltage reading.

d. Press [Ω] (ohms) on the Transmitter. If the bar graph shows a resistance greater than 1 k ohm, try to reduce the resistance by placing a far-end ground on the shield. If the far-end is already grounded, seek a better ground at the Transmitter.

e. Press [TRACING] (trace) and then [f Hz] to choose the lowest frequency.

Note: Two tracing frequencies may be simultaneously applied to the cable. Grounding and soil conditions may cause one to work better than the other. The second frequency may be selected using f_2 .

f. Look at the bar graph. It shows the relative amount of signal being fed to the cable. The signal level should be in the slanted portion of the graph but not above the center mark. If the bar graph is not reading in the slanted portion, make sure the far-end is well grounded and improve the ground at the Transmitter. If the bar graph is still not in the slanted portion, press f_1 to select a higher frequency. If the highest frequency will not give the correct bar graph level, then press to change to high output power. High output power may be necessary when the cable is very long.

g. The Transmitter set up is complete. Go to Section 2, para. 1.4 and prepare the Receiver.

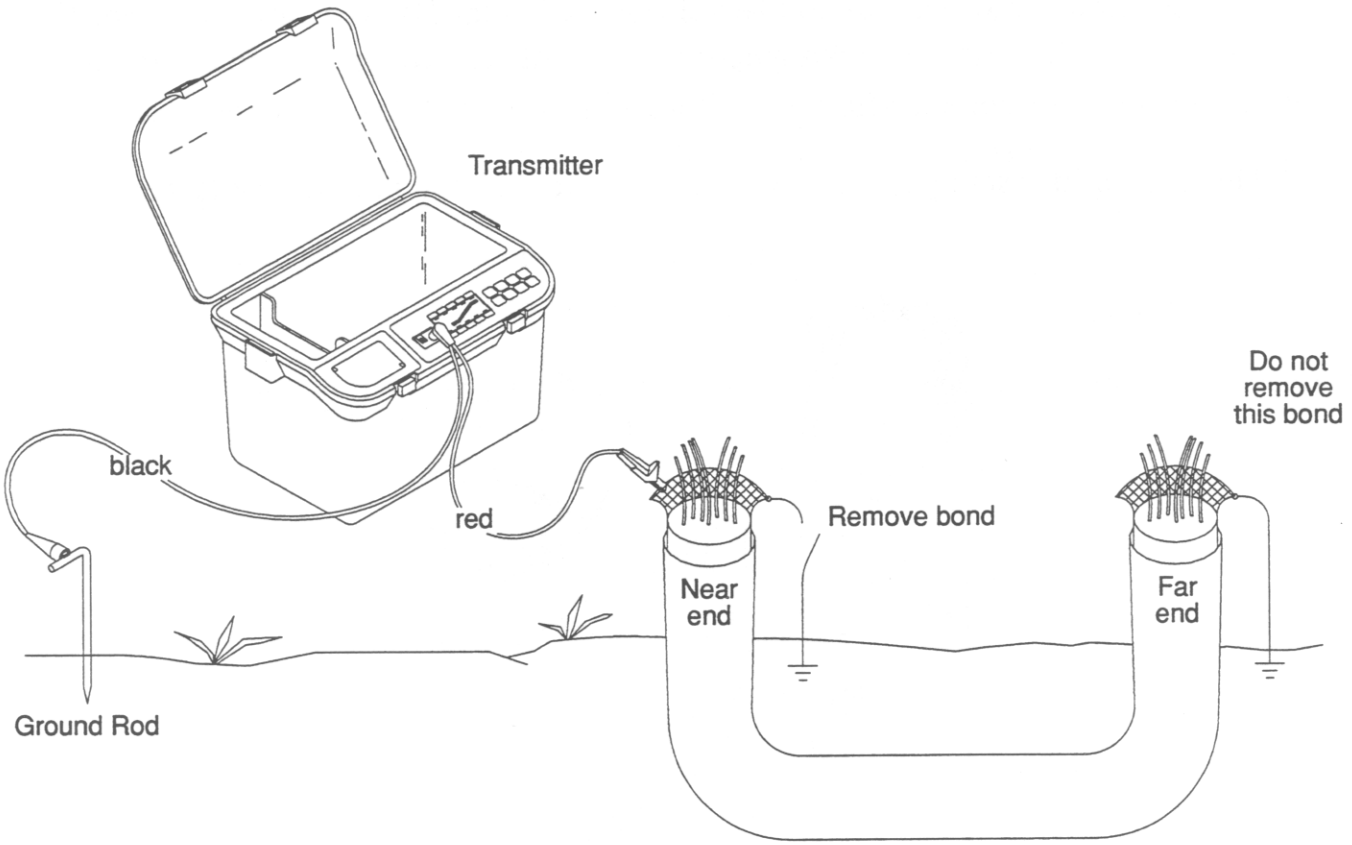


Fig. 2–2 Direct Connect Method

Dyna-Coupler Method

a. Connect the Extension Cable between the Dyna-Coupler and the Transmitter's ⇝ (input/output) jack. Clamp the coupler around the cable below any bond just before the cable enters the earth (refer to Fig. 2–3). There is no minimum cable size, but the jaws of the coupler must fully close for tone transmission.

b. Press the Transmitter ⏻ to turn the Transmitter on. The Transmitter beeps every four seconds. Press ⏦ (trace) and then f_1 to choose the F3 (33 kHz) frequency.

> ***Note:** Two tracing frequencies may be simultaneously applied to the cable. Grounding and soil conditions may cause one to work better than the other. You can select the second frequency* F4 *using* f_2.

c. Press ∿ to change to high output power. All segments of the bar graph go black.

d. Use the Receiver to test the signal level when using the Dyna-coupler method. If the Receiver has trouble picking up the trace path, return to the Transmitter and switch to a higher frequency (use f_1). Re-check the signal level with the Receiver.

e. The Transmitter set up is complete. Go to para. 1.4 and prepare the Receiver.

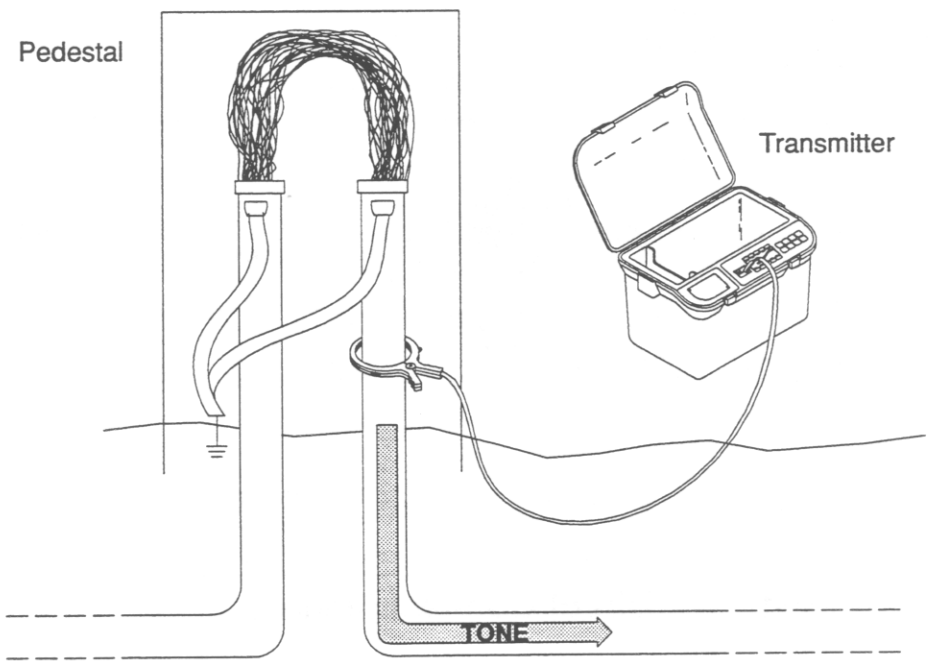


Fig. 2–3 Dyna-Coupler Method

Induction Method

a. Place the Transmitter on the ground over the cable to be traced. The Transmitter carrying strap brackets should be parallel to the cable path. Be certain that the Transmitter is directly over the cable to be traced.

b. Press [⏻] to turn the Transmitter on. The Transmitter beeps every four seconds. Press [TRACE] (trace) and then [f_1 Hz] to choose the [F3] (33 kHz) frequency.

> ***Note 1:*** *When using the induction method, the Transmitter indicates the two lowest frequencies are not recommended. If you select the lower frequencies, the flag over the frequency legend flashes to warn that a non-recommended frequency was selected.*
>
> ***Note 2:*** *Two tracing frequencies may be simultaneously applied to the cable. Grounding and soil conditions may cause one to work better than the other. You can select the second frequency by pressing* [f_2 Hz] .

c. To test the signal level when using the induction method, put the Receiver in (peak) mode and place it on the ground 50 feet away. Move the Transmitter back and forth across the path. Listen for strongest tone from the Receiver. If the Receiver has trouble picking up the trace path, return to the Transmitter and switch to the next higher frequency (use [f_1 Hz]). Re-check the signal level using the Receiver. If the highest Transmitter frequency does not give satisfactory Receiver response, then press the Transmitter [~] to change to high output power.

d. The Transmitter set up is complete. Go with para. 1.4 and prepare the Receiver.

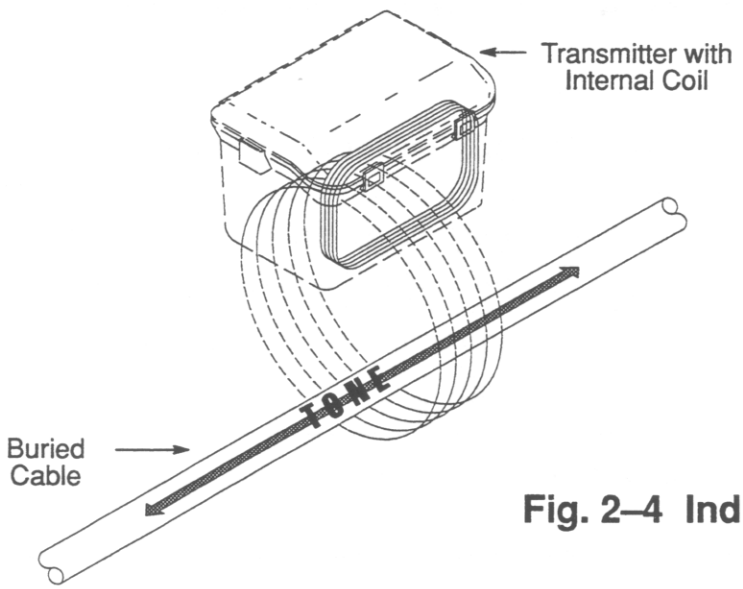


Fig. 2–4 Induction Method

B. Receiver Set-up to Trace

1.4 Connect the Antenna to the Receiver using the Receiver-Antenna cable. The right-angled plug attaches to the Receiver connector marked ANT and the other end goes to the Antenna. Turn on the Receiver by pressing [⏻].

1.5 Select the trace mode by pressing [⚡]. Each successive press of this key steps to a different mode. A flag (▲) appears under the selected mode.

1.6 After selecting a trace mode, press [ƒ Hz] and select the same frequency as the Transmitter. Each successive press of this key steps to a different frequency, including the passive [⚡] (power) and [LF] (512 Hz) frequencies. A flag (▼) appears above the selected frequency.

1.7 The Receiver is now ready to trace the buried cable. If you are using either the Dyna-Coupler or Induction methods to put tone on the cable, the Receiver may now be used to test the signal level. If you selected a second frequency during Transmitter set-up, be sure and test the signal level of both frequencies.

1.8 If you selected ∧ (peak) or ∨ (null) mode, you must also set the Receiver gain. Step away from the Transmitter and make broad sweeps over the suspected trace path. Locate a peak or null depending on which mode you are using. Stop the sweeps at a maximum bar graph closure and press [⚡] (gain). The Receiver sensitivity is automatically adjusted up or down to maintain a satisfactory signal level. The bar graph nearly goes together (almost all segments visible) and the numeric indicator reads a maximum value (∧ mode) or minimum value (∨ mode). You can adjust the speaker volume by pressing [🔊].

1.9 Start tracing the cable. When tracing, remember that the most powerful signal is near the Transmitter. As the Receiver gets farther away from the Transmitter the signal strength drops off. It is necessary to re-adjust the gain periodically to be sure there is adequate signal for the Receiver to operate. Press [⚡] (gain) when the bar graph is no longer visible (too little signal) or when the bar graph is closed (too much signal).

> ***Note:*** *The ⇨|⇦ (differential) mode does not require gain adjustment and [⚡] is inoperative.*

1.10 The [expander] function enhances all the trace modes. It boosts the response of the bar graph to make peaks and nulls more pronounced. With [expander] on, the bar graph is much more sensitive to changes in signal level. If the antenna is moved briskly across the trace path, the bar graph opens, closes, then opens again very quickly. Speaker audio follows the bar graph. In (peak) mode, as the antenna is moved across the trace path, the audio is heard only when segments of the bar graph are visible. Since the bar graph is changing rapidly, the speaker appears to 'beep' as the antenna crosses the trace path. The (null) mode audio is the opposite with audio blanked as the antenna crosses the trace path. Use [expander] to pinpoint a trace path if the signal is weak or the cable is deep.

C. Determining Cable Depth

1.11 At any time during the tracing operation, press [depth] to display the estimated depth to the buried cable. Place the Receiver Antenna on the ground directly above the cable, with the handle parallel to the path. Press [depth] (depth). The numeric indicator reads the calculated depth in feet and inches (refer to Fig. 2–5). Press [depth] (depth) again to continue.

> ***Note 1:*** *When the depth estimate is unreliable, the display shows three bars (- - -). When the received signal level is too low, the display shows (Lo). When the received signal level is too high, the display shows (HI) which would be the case for a shallow cable driven by a high-powered Transmitter.*
>
> ***Note 2:*** *When using the induction method of applying tone, depth readings taken less than 50 feet from the Transmitter may be erroneous.*

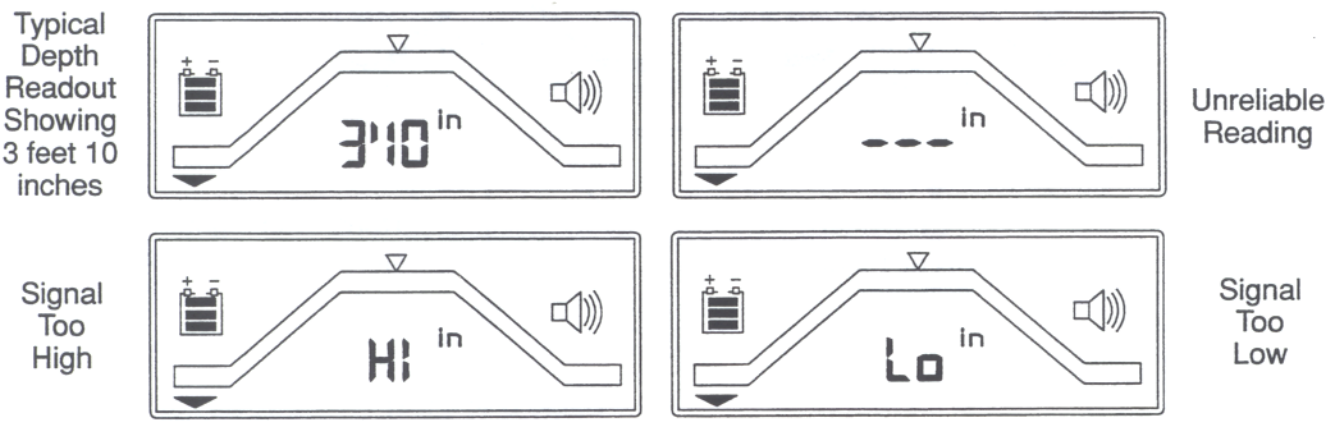


Fig. 2–5 Cable Depth Readouts

D. Identifying a Cable by Depth-Current Measurement

1.12 Transmitter tone applied to a cable by either the direct connect method or the Dyna-Coupler method can travel on your target cable as well as other cables that share the same ground. When you start to trace your cable with the Receiver you may find more than one cable with the signal on it. The cable with the most signal strength (highest reading on the numeric display) may not be your target cable because it may be a shallow buried cable (a shallow buried cable with a weak signal can give as good a Receiver response as a deep buried cable with a strong signal).

1.13 In Fig. 2–6, Transmitter tone was applied to cable 'B' and a strong signal current travels its length. Cable 'A' shares the same ground as cable 'B' and now carries the same tone, but the signal current is greatly reduced. Since cable 'A' is shallow (about one foot), it gives a strong ⩘ (peak) mode response even though the deeper cable 'B' carries more signal current. To identify which response comes from cable 'B', find the peak response over each cable and press [⏚] (depth). During depth measurements, the bar graph indicates the strength of the signal current in the cable. The cable with the most current has the greatest bar graph closure and is the target cable. Carefully check the bar graph because a two-segment difference in current indication is sufficient to determine which cable carries the most current. Also check the depth readout. Most CATV cables are buried one foot or less. Telephone cables are buried at three feet. Power cables and gas pipes are at four feet.

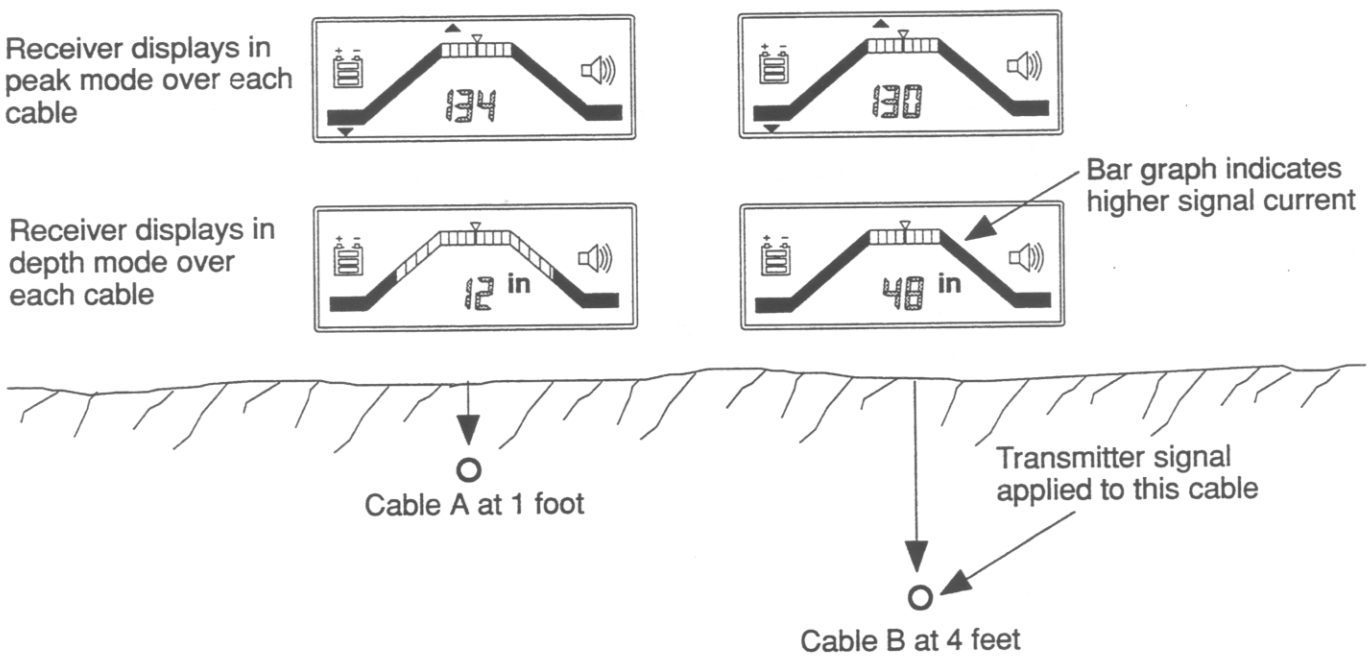


Fig. 2–6 Identifying Cables Using Depth-Current Measurements

1.14 When two cables with the same tone cross you can use the Depth-Current measurement to identify the target cable. Refer to Fig. 2–7. When cables 'A' and 'B' cross, they change depth. This is not unusual and is often the case. Since the Receiver's ⩘ (peak) mode signal response varies with depth, it may be difficult to identify the cables using signal level alone. However, the signal current in the cables will not change, and you can compare the bar graph reading using [⊤] (depth) to identify the cables.

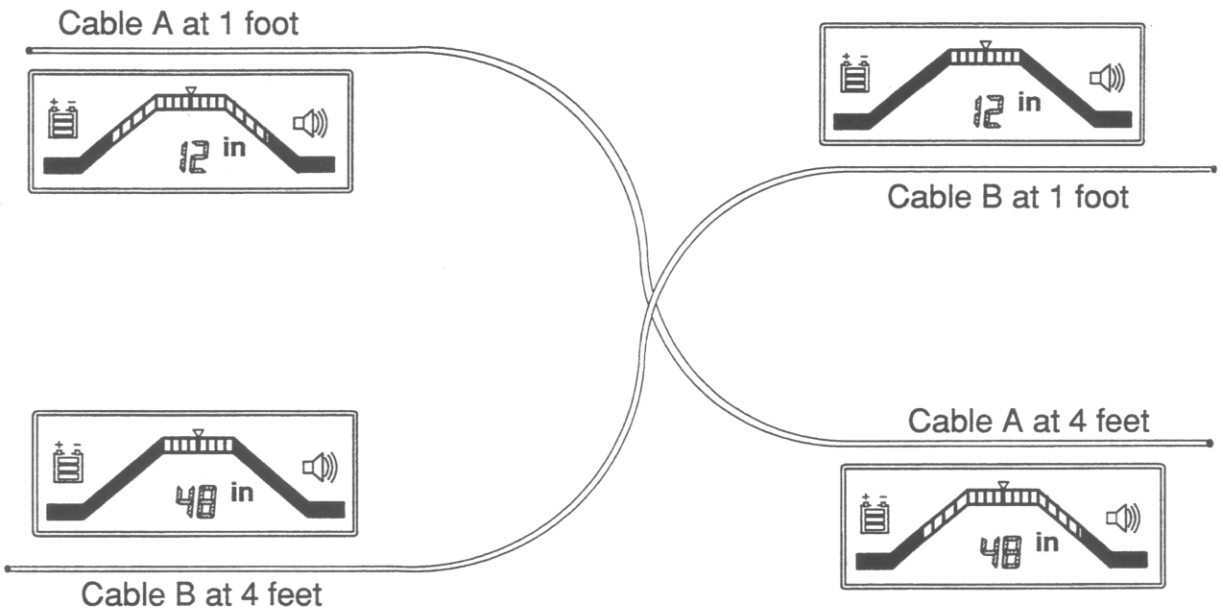


Fig. 2–7 Depth-Current Displays Over Crossing Cables

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Locating Techniques

1. General Locating Techniques

1.1 Achieving positive results requires knowledge of the equipment and the use of intuitive powers and good judgment. Certain techniques that, when properly used, alert the technician to potential problems. The minimum requirement for locating cables in the field is an understanding of the basics of applying tone and identifying signals.

A. Transmitter Techniques

1.2 There are three methods of applying tone with the Dynatel Transmitter:

- Induction method
- Direct connect method
- Dyna-Coupler method

Induction Method

1.3 The induction method is the simplest method of putting tone on a buried cable. An antenna coil inside the Transmitter case sets up an electric field that links with any parallel cable within its range. A signal current (tone) is induced into the linked cable. Signal magnitude depends on the Transmitter frequency and also on how well the cable is grounded. In general, a frequency of 30 kHz or higher is effective for induction. Higher frequencies link into adjacent cables. If more than one cable is linked by the Transmitter field, the one with the best grounding at both ends carries the strongest signal.

1.4 Do not use the induction method around congested facilities locations such as trailer parks where other buried cables are nearby, such as gas or water pipes, cable TV, and lawn-watering control circuits. Any conductive line picks up tone, particularly if the Transmitter output level is set to high output power (a flag above ).

1.5 Since the field emanating from the Transmitter coil is uniform the Receiver can directly detect it even if no cable exists between the Transmitter and Receiver. The Transmitter tone can travel over the earth's surface for a limited distance and show up as a signal on the Receiver if the Receiver is placed too close to the Transmitter. To avoid tone detection on a direct basis, place the Transmitter and Receiver at least 50 feet apart.

1.6 For the best performance, place the Transmitter directly over the cable to be traced with the antenna coil parallel to it (refer to Fig. 3-1). Placement of the Transmitter five or ten feet to either side of the cable results in a highly attenuated induced signal.

One-Person Operation

a. To induce a signal in the cable, place the Transmitter directly over the suspected path with the carrying strap brackets in line with the cable.

b. With the Receiver in ⩓ (peak) mode, locate and mark the path of the cable about 50 feet away.

c. Put the Transmitter over the cable path at this spot (carrying strap brackets in line with the cable).

d. Proceed with normal cable location.

Two-Person Operation

a. Induce a signal over the cable area using the Transmitter.

b. With the Receiver in ⩓ (peak) mode and about 50 feet away from the Transmitter, obtain a maximum reading.

c. Direct the person with the Transmitter to move the instrument right or left until the Receiver shows a maximum reading.

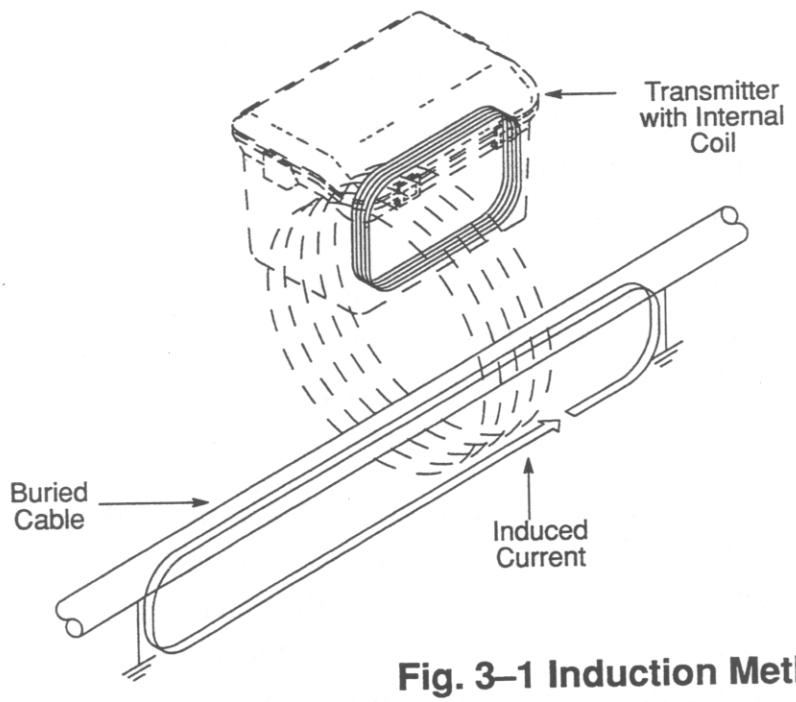

Fig. 3–1 Induction Method

Direct Connect Method

1.7 The use of the direct connect method is probably the most accurate method of cable locating, since the tone signal is isolated to one cable (refer to Fig. 3–2). When the red lead of the Transmitter is connected to the cable, signal current (tone) travels down the cable. The return path to the Transmitter is through the ground. The circuit is completed by connecting the black lead to the ground stake. This ground connection is very important. Never ground to water pipe or other services in the area because the returning signal may create an out-of-phase condition that misleads the trace. Place the ground rod as far away from the cable path as possible (90 degrees from the suspected cable path). Remove the ground bonding at the near-end. The far-end should have a good ground. Use the Transmitter's Ω (ohms) mode to check ground resistance. If this resistance is greater than 1 k ohms, check the grounding connections. Frequency choices should be the lower frequencies, which goes farther down the cable.

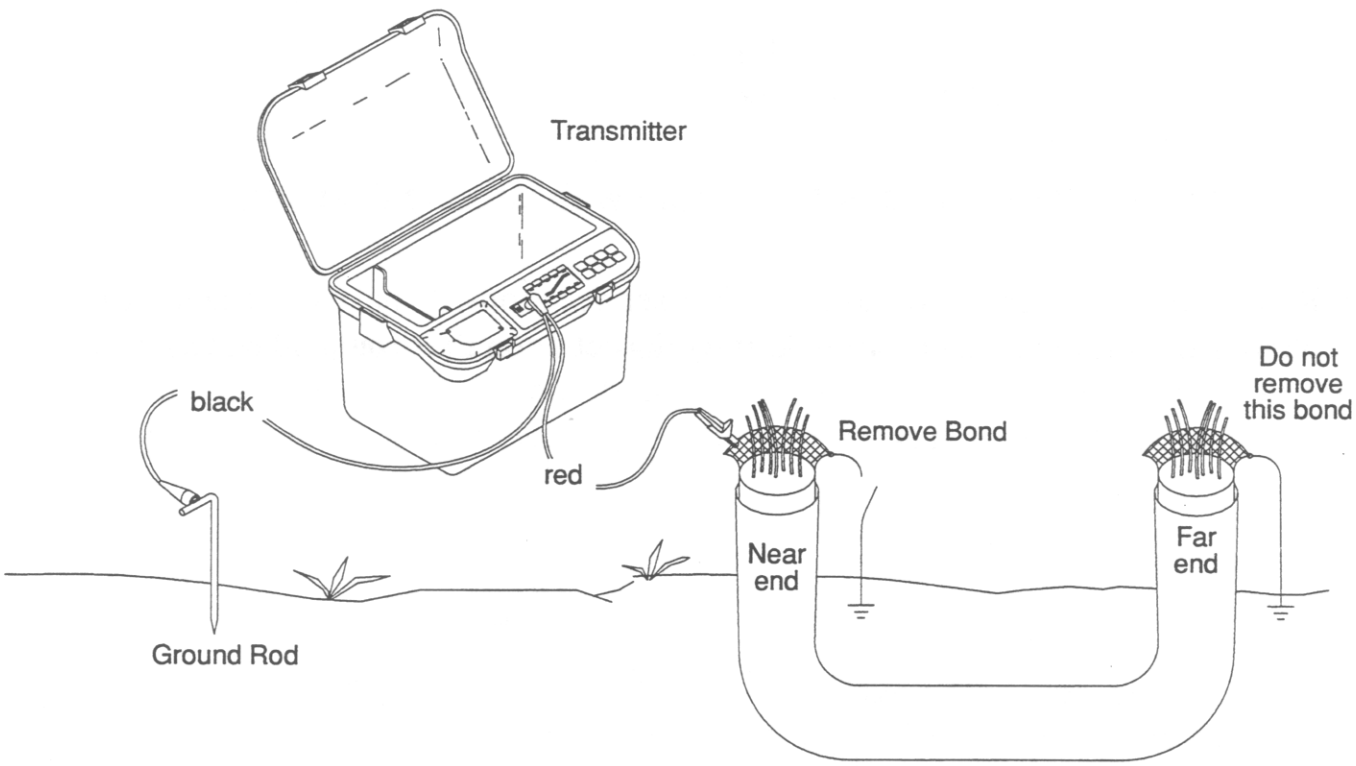

Fig. 3–2 Direct Connect Method for Tracing

Dyna-Coupler Method

1.8 If surface access to the cable is available, using the Dyna-Coupler is the easiest way to put tone on only one cable. Place the Dyna-Coupler around the cable making sure the jaws close completely. The Dyna-Coupler couples the Transmitter signal onto the cable. The cable and its grounds form a complete circuit path for the tone to follow. When the Dyna-Coupler is applied to the cable anywhere between grounds, tone is on the section between the grounds.

1.9 Refer to Fig. 3–3. Place the Dyna-Coupler on the cable between the ground bonding and the point where the cable enters the earth as in A. If the placement is above the ground bonding as in B, the tone is not coupled onto the cable.

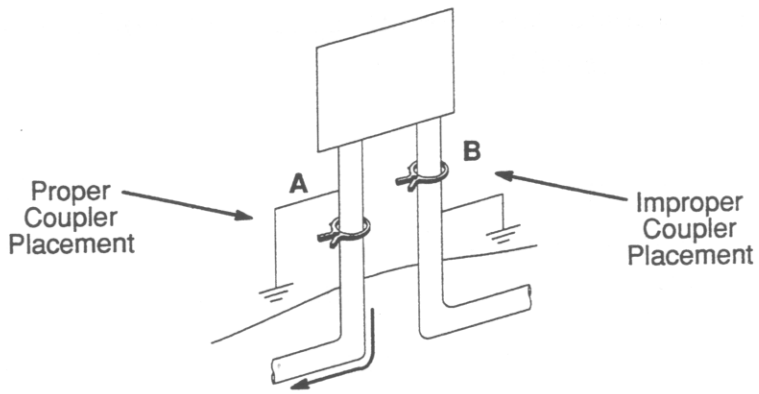

Fig. 3–3 Dyna-Coupler Placement with Ground Bonding

1.10 Refer to Fig. 3–4. On short cables, such as service drops, do not use the Dyna-Coupler on an un-grounded end as in A. It works better on the grounded end as in B.

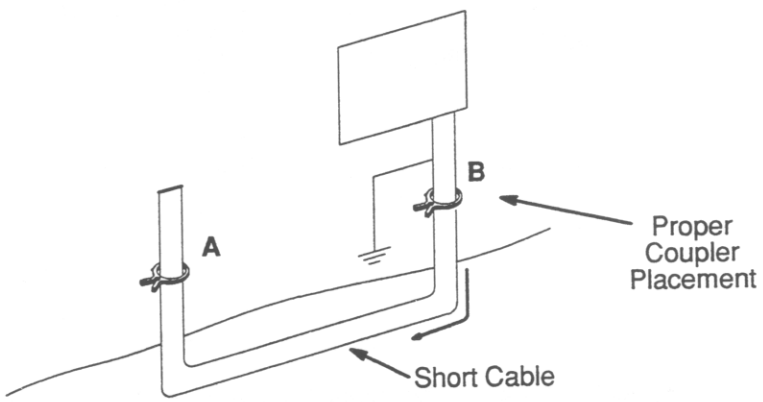

Fig. 3–4 Dyna-Coupler on Short Cable

1.11 If the cable is long, remove the bonding and tone goes both ways as in Fig. 3–5.

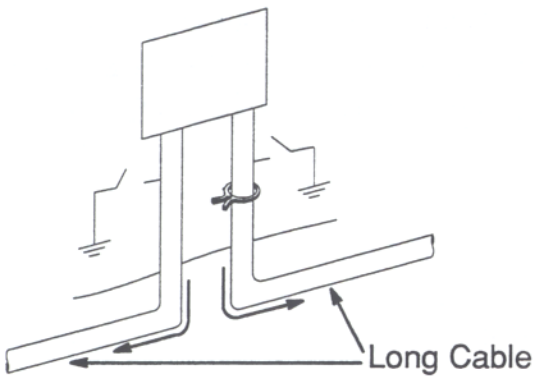

Fig. 3–5
Dyna-Coupler on Long Cable with Ground Bonding Removed

1.12 Clamping the Dyna-Coupler to a cable with drop lines or laterals puts full tone on the cable until the junction point. The lateral splits the tone evenly as in Fig. 3–6. When tracing, a drop in speaker volume and signal level is indicated on the Receiver when it passes the junction. This is an easy way to find laterals.

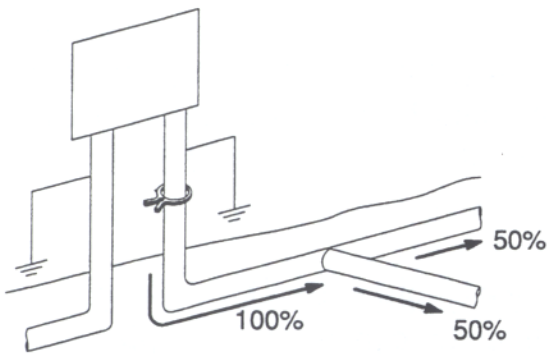

Fig. 3–6
Finding Laterals using the Dyna-Coupler

1.13 Several cables grounded at a common point (refer to Fig. 3–7) present no problem for the Dyna-Coupler method. Even though tone is coupled into each cable, the cable with the Dyna-Coupler is clearly identifiable because it has the strongest tone.

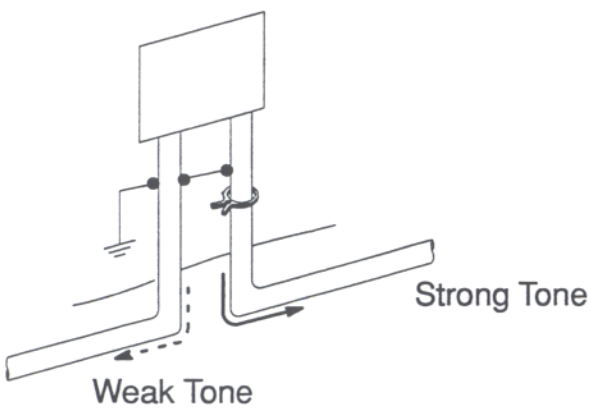

Fig. 3–7
Dyna-Coupler with Multiple Cables Grounded at a Common Point

B. Choosing Transmitter Frequencies

1.14 With any method of applying tone, frequency choices are important to get the most signal on the cable. An insulated, buried, cable behaves as if it has a string of capacitors along its length, and a signal applied to the cable leaks off through these capacitors to ground. As we move away from the Transmitter, the signal gets weaker and finally disappears. How fast it leaks off is determined by:

- the diameter of the cable,
- whether the soil is wet or dry, and
- the frequency of the signal.

1.15 Since these conditions vary, the Transmitter offers four frequency choices:

[F1] **(577.5 Hz):** Use this frequency when tracing over long distances. It is too low for use with the Dyna-Coupler or the Induction methods. It does not couple easily to other buried cables.

[F2] **(8 kHz):** This medium frequency is a general purpose signal. It is not recommended for use with the Dyna-Coupler and Induction methods because it may not put a strong signal on small diameter cable. It has limited cable-to-cable coupling.

[F3] **(33 kHz):** A high frequency easily applied by either the Dyna-Coupler or the Induction methods. It travels well on small diameter cables but it couples easier to other buried cables. Use this frequency to trace sections less than one-half mile.

[F4] **(200 kHz):** Use for difficult conditions such as dry sandy soil, faulted cables, or open ended or stubbed cables. This frequency couples very easily to other buried conductors and does not travel far.

1.16 With [f Hz 1] and [f Hz 2], you can apply two transmitter frequencies at once. This is very useful when conditions are unknown. With two frequencies on the cable, it is easier to identify the cable. Also, one frequency may travel farther than the other. This could save you a long walk back to the Transmitter.

C. Receiver Techniques

Signals not Transmitted by the Dynatel Transmitter

1.17 Two signals not transmitted by the Dynatel Transmitter that the Receiver can trace are [⏦] (60 Hz power influence) and [LF] (512 Hz). Power influence generated by the 60 Hz current flowing in power cables can induce a signal into nearby telephone cables. Without using the Dynatel Transmitter, the Receiver can passively locate and trace telephone cables from the induced signal. The [LF] (512 Hz) signal, however, is usually generated by a high-powered transmitter rack-mounted in the central office. Primarily, this transmitter is used for tracing or locating fiber optic cables.

1.18 The Receiver's [⏦] (power) and [LF] (low frequency) features enable it to detect these two signals to provide additional line locating possibilities. For instance, lines located with a passive sweep using the [⏦] (power) frequency can then be traced with an active signal from the Transmitter. When excavation is planned to a cable located and identified with an active signal, give the area a passive sweep to check for other nearby lines that could be damaged during excavation.

Power Frequencies

1.19 When a power cable is energized, it produces a signal at 60 Hz and harmonics of 60 Hz (180 Hz, 300 Hz, 420 Hz, 540 Hz and so forth). In a three-phase installation the 60 Hz signal is canceled but the ninth harmonic (540 Hz) is reinforced generating a stronger signal to trace. The [⏦] (power) mode is well suited for locating three-phase cable because it operates at the ninth harmonic of 60 Hz (540 Hz).

1.20 The design of some power cables minimizes radiated signals and they are difficult to detect in the [⏦] (power) mode. Also, many high voltage cable loads are balanced and the better the balance the more difficult detection becomes. Therefore, a simple passive search using [⏦] (power) might easily detect an energized street light cable but miss a 10 kV main power cable nearby. Note that a cable must be energized to be detected. If a street light is not on, its cable is not energized.

1.21 Although 60 Hz is a relatively low frequency, it can still couple into other cables buried nearby. Thus, a signal may be detected but impossible to identify because it could be coming from an energized power cable, a nearby pipe, or even concrete reinforcing bars. The knowledge that these cables or conductors exist is useful, however.

512 Hz Frequency [LF]

1.22 [LF] is intended primarily for tracing fiber optic installations. It is especially suited for tracing long fiber optic runs because it does not attenuate as rapidly with distance as one of the higher frequencies such as [F2], [F3], or [F4]. If a customer-owned 512 Hz rack-mounted transmitter is used, ensure that it is energized and attached to the appropriate fiber run.

Choosing Trace Modes

1.23 Select the trace mode by pressing [⏃] on the Receiver. Each successive press of this key changes the trace mode. A flag (▲) appears under the selected mode. The following is a brief description of each trace mode:

a. **Peak**⩓**:** In this mode, the Receiver speaker volume increases to a maximum as the antenna crosses the cable. It diminishes as the antenna moves off the cable path. Simultaneously, the bar graph fills from both sides toward the middle as the 'peak' zone is crossed then opens as the midpoint is passed. The numeric strength indicator also increases to a maximum. ⩓ (peak) mode is useful when tracing changes in cable direction because speaker volume falls off rapidly if the antenna handle is not in line with the cable path. In such a case, a sharp turn or bend in the path is indicated. For best results, keep the unit's bottom level with the ground.

b. **Null**⩔**:** In this mode, a signal picked up by the antenna coils cancels when the antenna is directly over the cable. The speaker is silent (null), the bar graph fills from both sides toward the middle, and the numeric strength indicator reads a minimum value. As the antenna moves past the cable midpoint, the speaker sounds because the signal is present but not canceled. ⩔ (null) mode gives a more precise center point than ⩓ (peak). Move the Receiver across the suspected cable path with a swinging motion. In ⩔ (null), the point of maximum bar graph segments and minimum speaker tone is the cable path.

c. **Differential**⇨|⇦**:** In this mode, the Receiver provides an indication of the relative position of the cable to the Receiver antenna by using the ⇨⇦ arrows on the display (the arrow points towards the cable). The bar graph and numeric strength indicators increases to a maximum as the Receiver antenna is moved directly over the cable path. The Receiver produces a high warbling tone when the antenna is to the right of the cable path and a low warbling tone when to the left. If the antenna is

stopped directly over the cable path, the tone does not warble. Use the relative position feature (⇨|⇦) to search for a lost or unknown cable path. Use of this mode in very congested areas may give false indications.

d. **Special Peak Mode:** In cases where the signal is too weak for tracing, it is possible to increase the signal sensitivity of the Receiver in the ⩓ (peak) mode. Turn the Receiver off, then on and quickly press and hold ⊳ (gain) until the power-up beep sounds. Select ⩓ (peak) mode. The ⩓ (peak) indicator should be flashing indicating successful selection of the Special Peak mode. To return to the normal ⩓ (peak) mode, turn the Receiver off and then back on. The Special Peak mode is not available when ↗ (power) frequency is selected. Also, use special attention when using the Special Peak mode because it is more susceptible to congestion than the normal peak mode.

D. Locating Techniques

1.24 There are three techniques using the Receiver for locating a cable:

1. Positioning to determine direction;
2. Tracing to locate the path; and
3. Sweeping to find a response.

Positioning

1.25 Positioning is a technique used to quickly find the trace path of a buried cable. The technique can save time when the signal is lost while tracing. Use this technique rather than starting over.

1.26 Place the Receiver in ⇨|⇦ (differential) mode. Place the antenna on the ground and rotate the Receiver around the antenna as if it were a pivot (the antenna and the Receiver are attached). Watch the left-right arrows on the display. There is a point where a small counter-clockwise rotation lights the right arrow and a small clockwise rotation lights the left arrow. At this point note the direction of a line through the Receiver handle. Turn the Receiver 90 degrees from this line (right or left makes no difference). One of the direction arrows is visible. Side step in the direction of the arrow until the Receiver indicates that the cable has been crossed.

Tracing

1.27 Tracing a cable with the Receiver is probably the most common technique. To get the most accurate results, tone should be isolated to the individual cable. This means using either the direct or Dyna-Coupler methods of applying tone. If surface access is not possible, then use the induction method. Place the Receiver in either (peak) or (null) mode and press the (expander) on. Trace the cable at a slow walk while moving the Receiver in a side-to-side motion. Periodically mark the path.

Sweeping

1.28 Sweeping is used to cover a large area to locate all buried cables. Set the Receiver to (peak) mode with (expander) off. Apply the Transmitter signal using the induction method. Use the highest frequency so that all cables carry tone. The Receiver can also be used in (power) mode to verify that all the buried cables have been found. Walk in a grid pattern over the chosen area (refer to Fig. 3-8). Note that this covers the area from two directions. Stop the sweep when there is a response. Locate the position of the cable then trace it until out of the area. Mark the path with an aerosol paint spray, road crayons, or other means. After tracing the cable, resume the sweep.

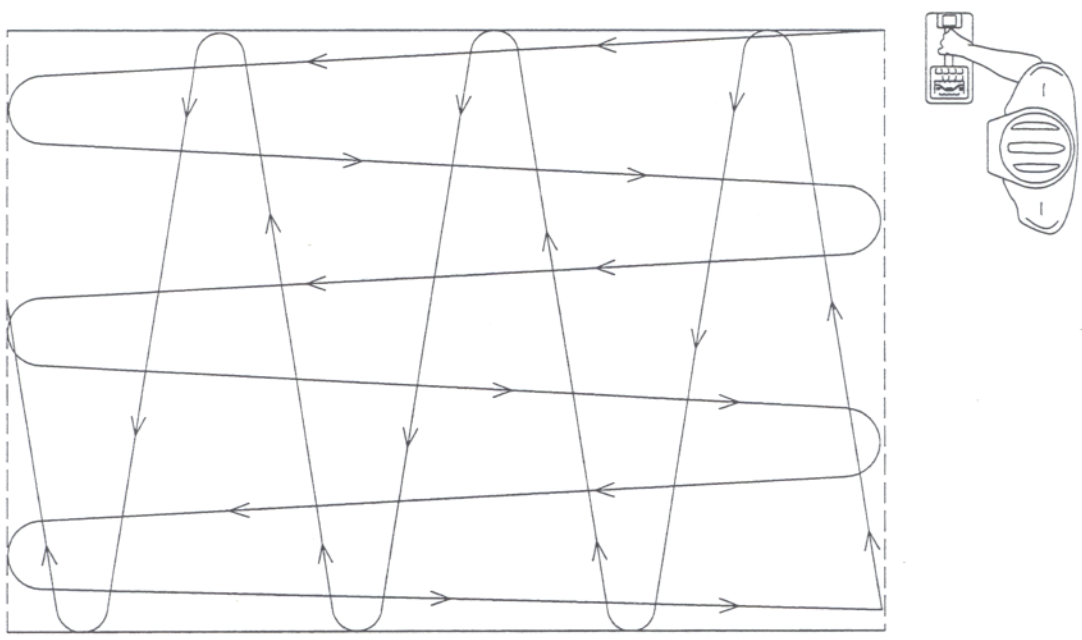

Fig. 3–8 Sweep Pattern

Special Applications

1. Identifying Cables

1.1 This procedure identifies a single cable in a group of similar cables.

a. At an access where cable identity is known, use the Transmitter to put tone on the sought cable with the Dyna-Coupler method. Press [f Hz] to select the highest frequency available. Output level should be set to high using [~]. It is not necessary to remove any bonds or ground.

b. At an access at the far-end of the cable group, connect another Dyna-Coupler to the Receiver's ⊂ (coupler) jack with the Dyna-Coupler Extension Cable.

c. Select ∧ (peak) trace mode by pressing [ ]. Select the same frequency as the Transmitter by pressing [f Hz]. Check that the expander is off (no flag under [ ]).

d. Check the first cable in the group by clamping the Dyna-Coupler around the cable. Press [ ] (gain) and observe the numeric display, which is relative signal strength. Remember the number and continue by clamping the Dyna-Coupler around the next cable in the group. If the signal strength is greater than the previous observation, press [ ] (gain). If the signal strength is less than before, ignore it. After checking all the cables in the group, the cable with the highest reading is the one being sought.

2. Pair Identification

2.1 This procedure identifies individual conductors within the same cable. It uses the Dyna-Coupler and an inductive probe, so none of the pairs need to be cut. The use of the high frequency also allows tagging of conductors in a wet pulp section (refer to Fig. 4–1).

a. At a splice or access, use the Transmitter to put tone on the pair to be identified using the Dyna-Coupler method. Connect the Dyna-Coupler Extension Cable between the Dyna-Coupler and the Transmitter's ⊸ (input/output) jack. Clamp the coupler around either tip or ring of the pair and make sure it is fully closed. Press [ ] to turn the Transmitter on. Press [ ] (trace) and then [f Hz] to choose the highest frequency available. Output level should be set to high using [~].

b. Take the Receiver and Inductive Probe to the location where identification is needed. Connect the Inductive Probe to the (coupler) jack of the Receiver using the 6-ft. probe cable. Both the probe and the cable are available as optional accessories.

c. On the Receiver, select the (peak) trace mode by pressing . Select the same frequency as the Transmitter by pressing . Check that the expander is off (no flag under).

d. Insert the probe into the bundle of pairs (or the group, if known) and press (gain). Next, divide the pairs into two bundles and insert the Probe into each of the bundles and observe the numeric display. The bundle with the highest reading contains the sought pair. Continue by dividing the bundle with the sought pair into two parts and checking each part for the highest signal. In this way the pair is isolated.

***Note:** There is a groove around the inductive Probe to indicate the location of the sensing coil. The coil is oriented so that maximum signal is sensed when the probe is perpendicular to the cable conductor (as shown below).*

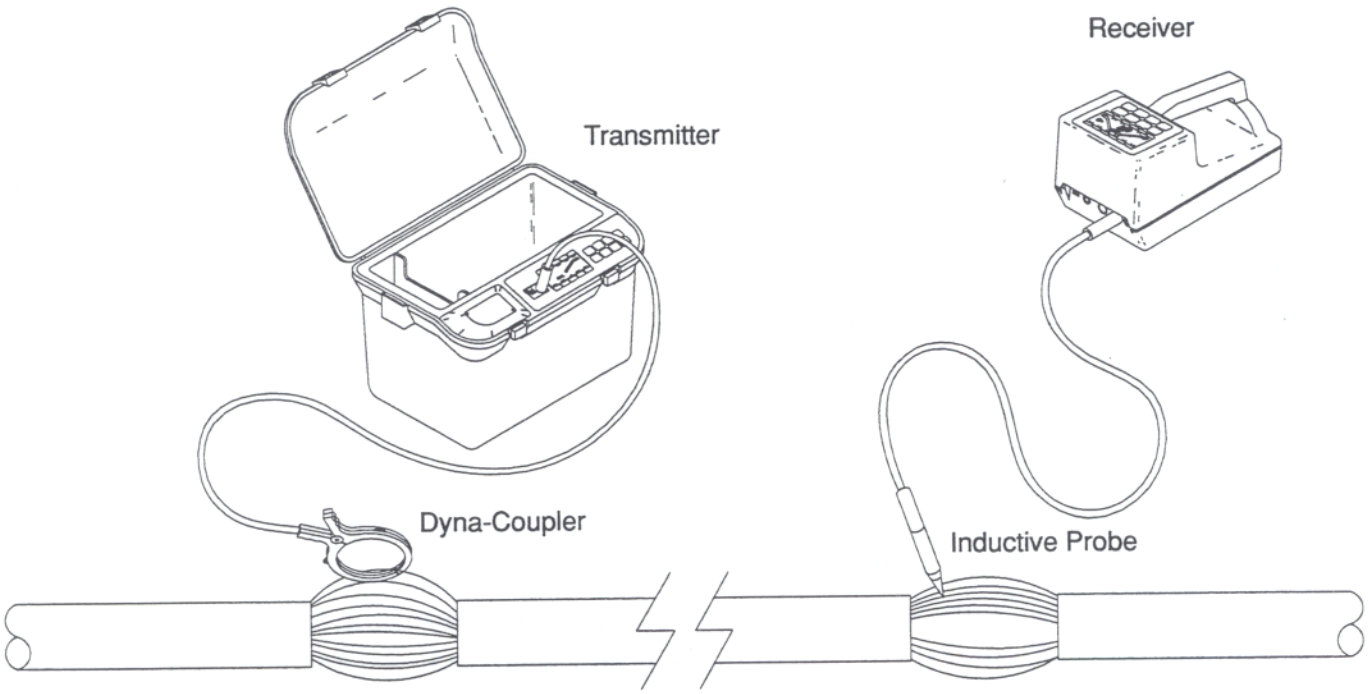

Fig. 4–1 Pair Identification

3. Locating Splits

3.1 To locate the splice where a split occurs, refer to Fig. 4–2 and use this procedure:

a. Attach the Transmitter to one pair of the split.

b. Strap the tips and rings of both pairs at a far-end access beyond the splice.

c. On the Transmitter, press [⇝] to select the tone mode.

WARNING

Potential for electrical shock exists when handling connecting cables while the Transmitter is in the [⇝] (tone) mode. Turn the Transmitter off before handling connecting cables.

d. A customer-supplied toning amplifier detects a weak tone from the Transmitter to the split, and strong tone from the split to the strap.

e. To verify that you have located the split, attach the Transmitter to a non-split conductor of one pair and a split conductor of the other pair. The tracing tone is strong from the Transmitter to the split, and weak from the split to the strap.

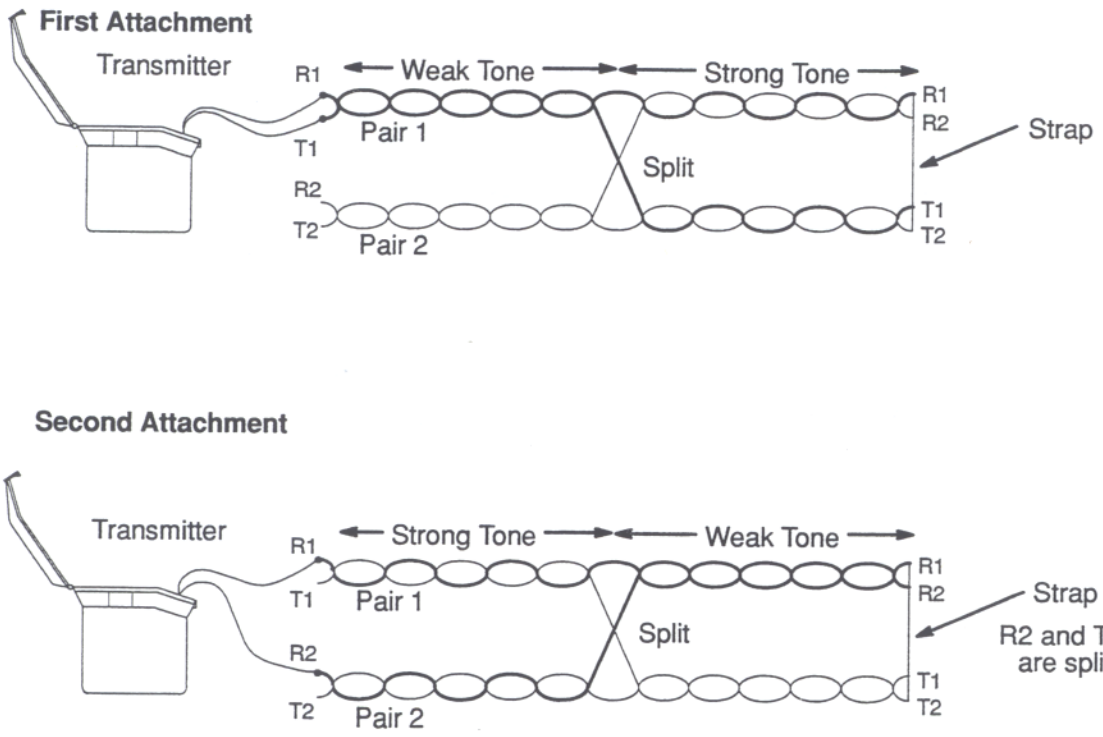

Fig. 4–2 Attachments for Split Location

4. Locating Slack Loops and Butt Splices

4.1 To identify the presence of a Slack-Loop or Butt-Splice in a cable path, first locate and mark the cable path. Retrace the path using this procedure (Fig. 4–3).

a. Check that the Receiver is in (peak) mode with (expander) off. Find a peak response over the marked cable path and press (gain).

b. If the antenna is attached to the Receiver, hold the Receiver so the handle is perpendicular (across) the cable path.

c. Retrace the cable path with the Receiver held in this manner. When the Receiver passes over a slack-loop or butt-splice, the tone increases and the bar graph closes. This indicates a sudden change in signal caused by an abrupt turn in the cable path which is now parallel with the antenna.

d. Mark each response. Whenever such a condition is encountered, it should be checked to see if an unknown lateral exists (refer to para. 5.1).

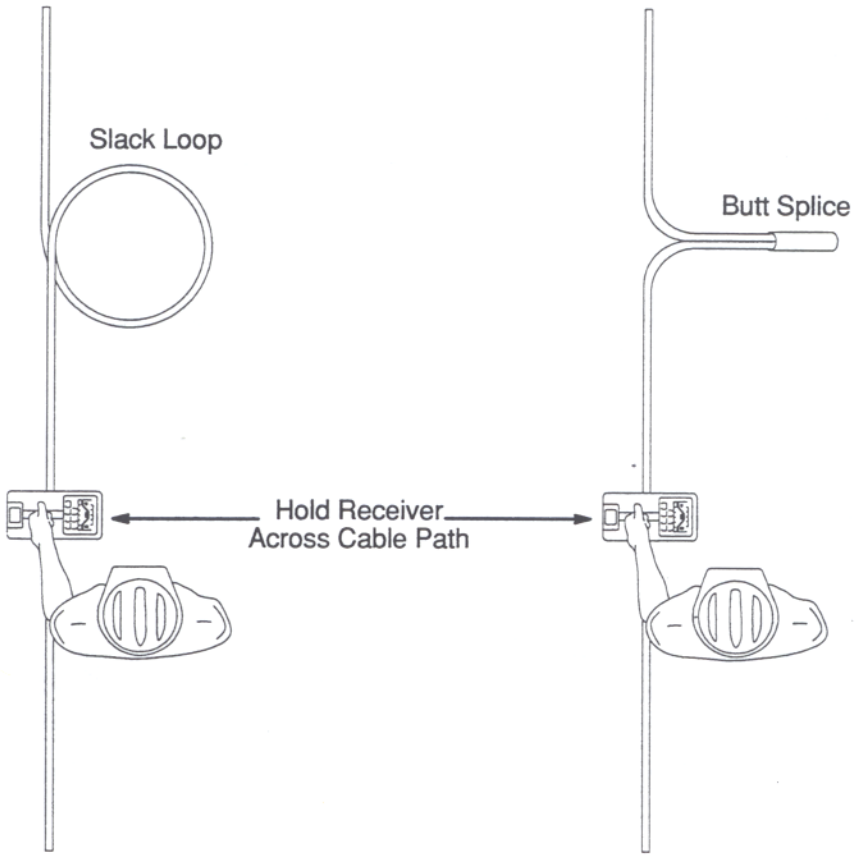

Fig. 4–3 Slack Loops and Butt Splices

5. Locating Unknown Laterals

5.1 To check for unknown laterals which may radiate from a butt-splice type of closure, first trace and mark the cable path. Retrace to locate any butt-splices or slack-loops using the techniques in para. 4.1. Mark the spot of any detected butt-splices or slack-loops. Follow this method to see if laterals exist:

a. Check that the Receiver is in ⩘ (peak) mode. If the Receiver gain has not been set while performing the normal trace, go to the marked trace path and pinpoint the path. Press [⩘] (gain).

b. Walk 10 to 25 feet off the trace path and away from the marked butt-splice or slack-loop. If the antenna is attached to the Receiver, hold the Receiver so that the display end of the handle points directly AWAY from the mark. Walk in a circle around the mark with the Receiver always pointing outward away from the mark.

c. The Receiver remains relatively quiet until it crosses a lateral or the actual cable path. Since there could be several laterals radiating from the closure, mark each occurrence of tone around the circle. After each lateral is located, its path may be traced and marked.

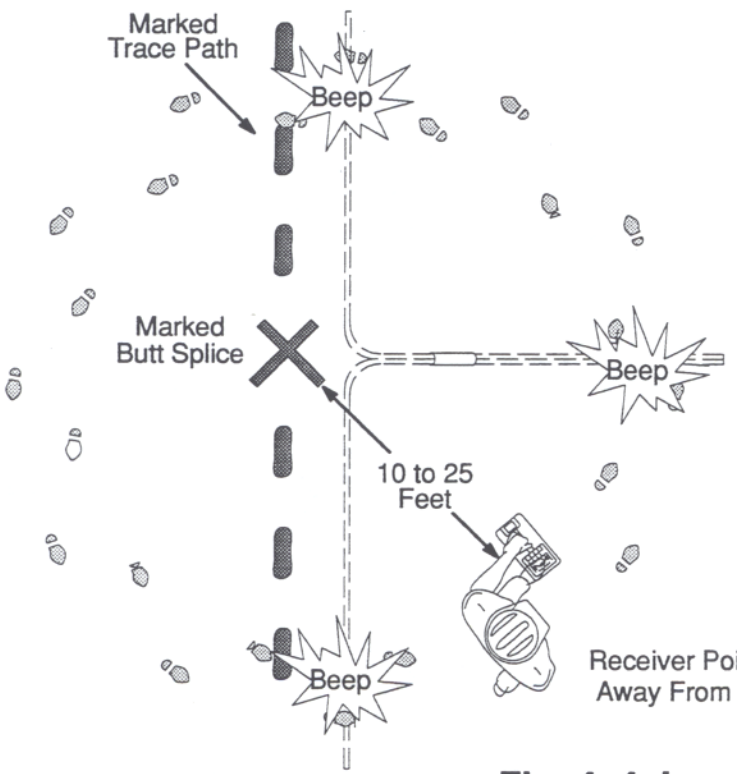

Fig. 4–4 Locating Laterals

6. Locating Cables from Pedestals

6.1 To locate a single cable path from a pedestal, follow these steps:

a. At the pedestal apply tracing tone on the target cable using the Dyna-Coupler method. If the header in the pedestal is not grounded, use the ground rod and ground extension cable to ground it.

b. Check that the Receiver is in the ⩓ (peak) mode and walk 10 to 25 feet away from the pedestal. Hold the Receiver so that the display end of the handle points directly AWAY from the pedestal. Start walking in a circle around the pedestal with the Receiver always pointing outward. Refer to Fig. 4–5.

c. The Receiver remains relatively quiet until it crosses a cable. Stop when there is a response. Find the exact peak and press (gain). Check the numeric display for relative signal strength. Remember the number and continue walking the circle. As you walk away from the cable the signal drops. Press (gain) and continue. When another response is encountered, find the exact peak. If the greatest signal strength is more than 25 points higher than the others (if any found), then that is the target cable. If the signal levels are closer, then measure the depth of each cable found and note the bar graph in the depth mode (this is a relative measurement of the current flowing in the cable). The cable that shows at least two more segments on the bar graph than the other cables is the target cable.

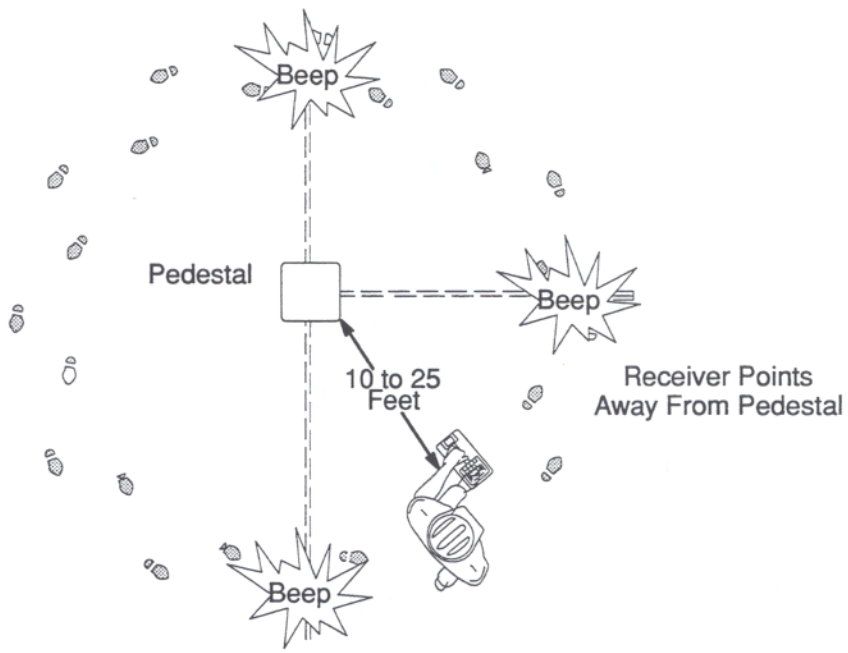

Fig. 4–5 Locating Cables from Pedestals

7. Locating Service Drops

7.1 When locating the path of a service drop from a house or other building, it is more convenient to apply tone at the house or building. Connect the Transmitter using the direct connect method. Use the standard tracing techniques described earlier.

8. Locating an Open End

8.1 To locate an un-terminated or open end of a cable or drop, follow these steps.

a. If the cable is bonded to ground at the access point, connect the Transmitter using the Dyna-Coupler method. Otherwise, if the cable is not bonded to ground at the access point, connect the Transmitter using the Direct Connect method. With either method, choose the highest frequency available.

b. Set the Receiver to ⩓ (peak) and trace the cable path. The tone decreases suddenly at the site of the clear or severed end.

9. Fiber Optic Locating

A. Typical Installation Practices

9.1 Fiber optic cables consist of fragile optical fibers encased in a strengthened outer member. The internal sheath of the cable may or may not be metallic. If it is not metallic, the manufacturer may include a metallic strength member (wire) within the sheath. Some fiber optic cables have no internal metal structure, in which case the contractor installing the cable may pull an insulated wire through the underground duct with the fiber optic cable. If a metallic conductor is not in or next to the fiber optic cable, the cable's path cannot be traced. The craftsman must then rely on site plans for physical location.

9.2 Underground fiber optic cable is normally installed in duct, or it may be placed in a smaller flexible plastic tube within the duct. The installation is normally made from a central office to a remote terminal office or distribution point (refer to Fig. 4–6). There may be several or many splice points in handholes or manholes along the route. Installation practices generally require that the fiber optic cable metallic sheath or strength member be grounded at the terminating ends. Bonding practices at the splice points vary by company. Therefore the metallic strength member may or may not be grounded or may be grounded through a remotely-actuated relay or a voltage transient suppression device. Some installations include a permanently installed rack-mounted transmitter that can selectively place a tracing signal on one of several fiber optic cables. If this transmitter produces a 577 Hz or 512 Hz signal, you can trace the fiber optic cable using the Dynatel Receiver.

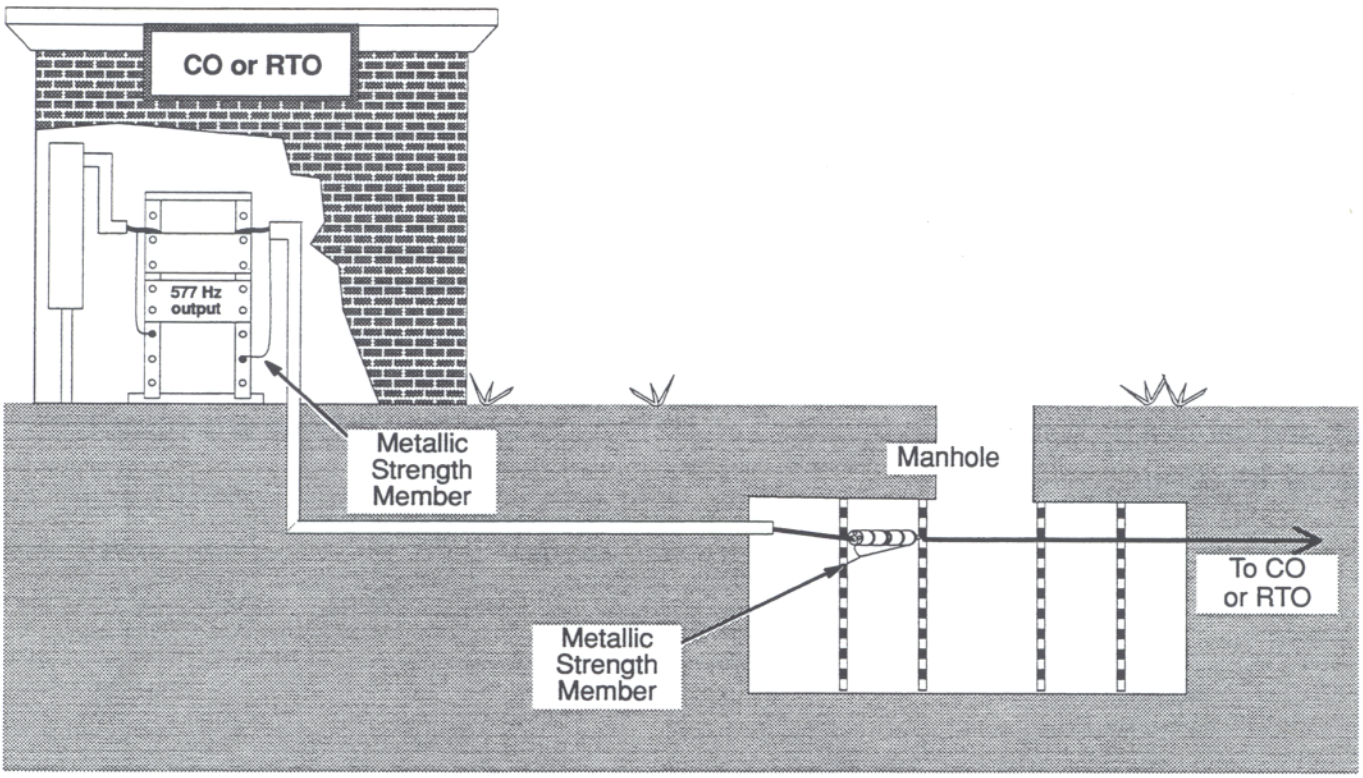

Fig. 4–6 Fiber Optic Cable Joining CO/RTO and Intermediate Spice Points

B. Establishing the Trace Signal

9.3 If the installation includes a rack-mounted transmitter, it must be set to either 577.5 Hz or 512 Hz, attached to the sheath or strength member of the fiber optic cable to be traced, and powered on. If the rack-mounted transmitter is not available, attach the Dynatel Transmitter at the CO/Remote Terminal Office or at an intermediate splice point.

Attaching at CO or Remote Terminal Office

9.4 To attach the Transmitter at the CO or Remote Terminal Office, bring it to the location in the office where the fiber optic cable strength member is grounded. Typically, this is near the rack-mounted digital conversion equipment. Locate and disconnect the metal strength member from the frame or rack ground point and follow steps a. through g.

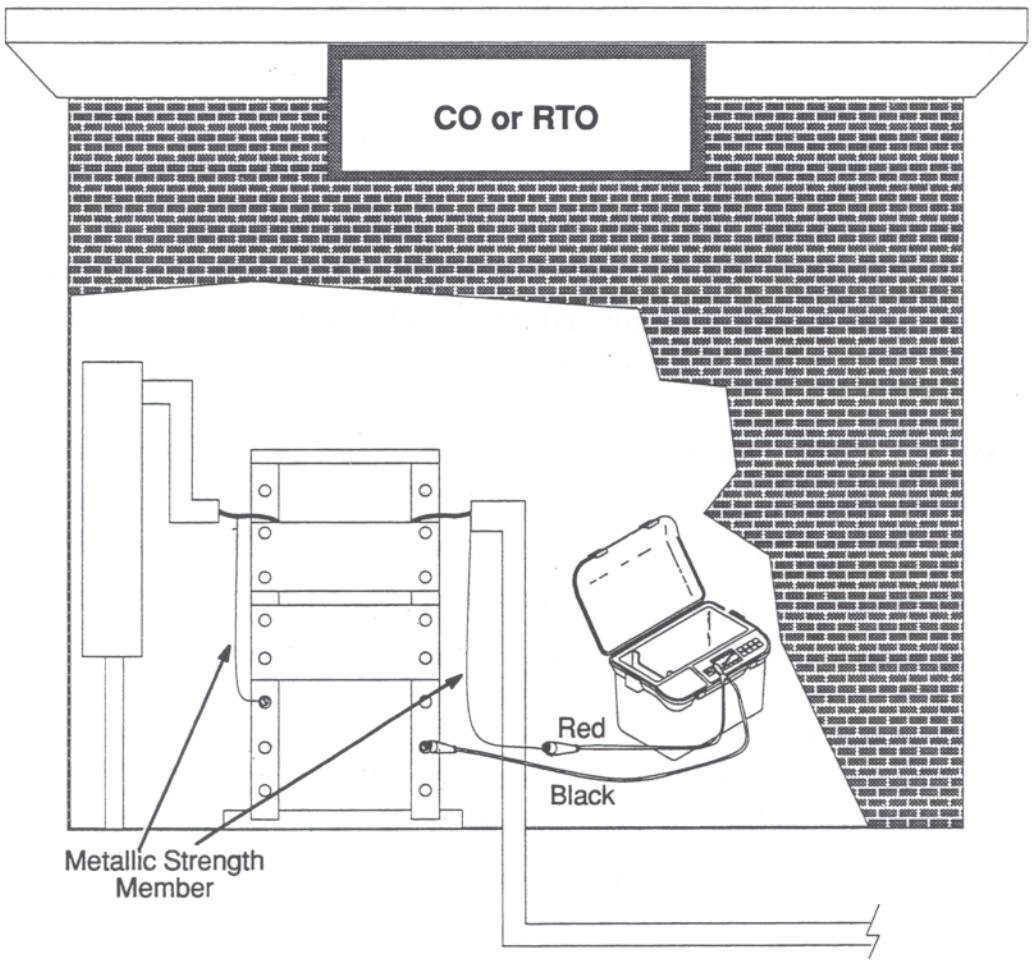

Fig. 4–7 Attaching at CO or RTO

CAUTION

Make all direct test connections before turning on the Transmitter. Then activate the Transmitter and check the display for voltage readings. Voltage higher than 130 volts will damage equipment. Follow standard procedures for reducing the voltage.

a. Make sure the Dynatel Transmitter is off. Plug the Direct Connect Transmitter Cable into the ⇜⇝ (input/output) jack.

Note: *Never ground to a water pipe or other services in the area. The return signal through these services may mislead the trace.*

b. Attach the Red clip of the Direct Connect Transmitter Cable to the fiber optic strength member and the Black lead to the frame or rack ground point.

c. Turn on the Transmitter by pressing [I/O]. The Transmitter activates in [V] (volts) mode and beeps every four seconds. Check the bar graph for a voltage reading.

d. Press [Ω] (ohms) on the Transmitter. If the bar graph shows a relatively high resistance (greater than 2 k ohms), there may be an open between this connection point and the ground at the terminating end or intermediate splice points. If the resistance is very low (less than 250 ohms), there may be another ground point on the strength member within the CO. Either condition probably causes very little of the signal to be placed on the fiber optic cable outside. An acceptable condition is a resistance reading between 250 ohms and 2 k ohms.

e. Press [TRACE] (trace) and then [f Hz 1] to choose [F1] (577 Hz) frequency. This frequency usually allows the longest trace. If tracing a distance less than three miles (approx. five km), add a second trace frequency of 8 kHz by pressing [f Hz 2] (flag above [F2]). In certain cases where the strength member is grounded at many points, [F2] (8 kHz) might provide a longer trace.

f. Check the bar graph. It shows the relative amount of signal being fed to the cable. The signal level should be in the slanted portion of the graph. If the bar graph is not reading in the slanted portion, make sure the far-end is well grounded and improve the ground at the Transmitter. Use [~] (high level output) if tracing fiber optic cable longer than .5 miles.

g. The Transmitter set up is complete. Go to para. 9.8 to prepare the Receiver.

> ***CAUTION***
> *Make all direct test connections before turning on the Transmitter. Then activate the Transmitter and check the display for voltage readings. Voltage higher than 130 volts will damage equipment. Follow standard procedures for reducing the voltage.*

9.7 Follow steps a. through g. to attach the Transmitter.

a. Make sure the Transmitter is off. Plug the Direct Connect Transmitter Cable into the ⇝ (input/output) jack. Connect the Black clip to the ground rod. Place the ground rod in the earth perpendicular to the suspected cable path. If necessary, extend the ground lead with the Ground Extension Cable.

> ***Note:*** *Never ground to water pipes or other services in the area. The return signal through these services may mislead the trace.*

b. Attach the Red clip of the Direct Connect Transmitter Cable to one or both metallic straps coming out of the splice case.

c. Turn on the Transmitter by pressing (I/O). The Transmitter activates in the [V] (volts) mode and beeps every four seconds. Check the bar graph for a voltage reading.

d. Press [Ω] (ohms) on the Transmitter. If the bar graph shows a relatively high resistance (greater than 2 k ohms), there may be an open between this connection point and the ground at the terminating end or intermediate splice points. This condition can cause very little of the signal to be placed on the fiber optic cable.

e. Press (trace) and then (f Hz 1) to choose [F1] (577 Hz) frequency. This frequency usually allows the longest trace. If tracing a distance less than three miles (approx. five km), add a second trace frequency of 8 kHz by pressing (f Hz 2) (flag above [F2]). In certain cases where the strength member is grounded at many points, [F2] (8 kHz) might provide a longer trace.

f. Check the bar graph. It shows the relative amount of signal being fed to the cable. The signal level should be in the slanted portion of the graph. Use (high level output) if tracing fiber optic cable longer than .5 miles.

g. The Transmitter set up is complete. Go to para. 9.8 to prepare the Receiver.

C. Tracing the Fiber Optic Cable

9.8 When tracing from a CO or Remote Terminal office, move to the cable's expected exit point outside the building.

a. With the antenna connected to the Receiver, select (peak) trace mode by pressing . Select the same frequency as the Transmitter by pressing to select F1 (577 Hz) or LF (512 Hz) for a rack-mounted transmitter, or F1 (577 Hz) if using Dynatel Transmitter. Check that the expander mode is off (no flag below).

b. Search the area until the unit receives the signal. When tracing at a manhole or handhole, walk in a circle around the hole with your back or front toward the hole. Move toward increasing signal strength adjusting Receiver gain as needed until you locate the cable. Then switch the Receiver to the preferred trace mode and trace the path of the cable.

Signal Attenuation

9.9 When tracing a cable over a long distance the signal strength decreases. This can be caused by the signal "bleeding" off into the earth due to capacitance or by additional grounds at splice points along the fiber optic cable. The "bleeding" effect causes a gradual reduction in signal strength as the Receiver moves along the cable. The splice- point ground causes an abrupt or distinct drop in signal because the signal is split between the outgoing fiber optic cable and the local ground. These intermediate ground points can severely limit the tracing distance unless you use a high-powered Transmitter. This abrupt drop in signal is a good indication of the presence of an earth ground at a splice point.

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Glossary

AC	Abbreviation for Alternating Current
alkaline	A type of non-rechargeable battery which may be used in the transmitter and the receiver.
amplitude	The maximum value of a varying quantity. A tone on a buried cable will have a certain amplitude which may be different from the tone on another buried cable. The receiver electronics can detect and display the difference.
attenuated	A general term used to denote a decrease in the magnitude of a signal from one point to another.
audio	A signal which can be heard by the human ear. Typically from about 15 Hz to 15 kHz.
CO	Central telephone switching office.
conductive	Property of a material which allows the passage of a signal or current.
expander	A function of the Receiver () which acts to increase the response more on larger signals than on smaller signals.
Hz	Abbreviation for Hertz. A unit of frequency equaling one cycle per second.
induction	A method of putting tone on a buried conductor by using a varying current in one circuit (the transmitter) to produce a voltage in another nearby circuit (the buried conductor).
kHz	Abbreviation for kilo-Hertz. Hertz times 1000; Example: 2.7 kHz equals 2700 Hertz.
k ohm	Abbreviation for kilo-Ohms. Ohms times 1000; Example: 2.5 k ohms = 2500 ohms.
lateral	An extension or branch from the main path of a cable.

LCD	Liquid Crystal Display
legend	Inscriptions or labels around the display. Used to indicate choices. Example: F1 F2 F3 and F4 are legends used to note the frequency choices.
megohms	Abbreviation for mega-Ohms. Ohms times 1,000,000. Example: 2.5 megohms = 2,500,000 ohms.
mode	method of operation
Ni-Cd	Abbreviation for Nickel-Cadmium. A type of rechargeable battery which may be used in the receiver and transmitter.
null	A receiver trace mode where the receiver will respond to tone on a buried cable by indicating minimum signal directly over the cable.
ohmmeter	Device for measuring electrical resistance.
peak	A receiver trace mode where the receiver will respond to tone on a buried cable by indicating maximum signal directly over the cable.
resistance	Property of a conductor which determines the current which will flow though it when a particular voltage is applied. Measured in ohms (Ω).
voltmeter	Device for measuring electrical potential difference.

Care and Maintenance

1. Care and Maintenance

A. Batteries

1.1 Either alkaline (non-rechargeable) or nickel-cadmium (rechargeable) batteries may be used in the Transmitter and Receiver. The Transmitter requires six D-size batteries and the Receiver requires five C-size batteries.

1.2 The alkaline batteries provide about three to four times as much operating time as nickel-cadmium batteries, but then must be discarded.

1.3 Nickel-cadmium (Ni-Cd) batteries may be charged several hundred times before they are thrown away, but they have some peculiarities the user should be aware of when using them. Refer to paras. 1.8 and 1.9. In the long term, Ni-Cd batteries can be cost effective.

1.4 The quality of both types of batteries varies considerably with manufacturer and model number. Therefore, in order to ensure more predictable results, only the batteries listed below are recommended.

- Transmitter: six, D-size Alkaline: Duracell MN 1300
- Transmitter: six, D-size Ni-Cd: Power Sonic PS-D/B
- Receiver: five, C-size Alkaline: Duracell MN 1400
- Receiver: five, C-size Ni-Cd: Power Sonic PS-C/B

We also recommend that you keep a spare set of batteries at the worksite to minimize interruption of work.

B. Installing or Replacing Batteries

1.5 To install or replace the Transmitter batteries, remove two screws from the battery compartment cover to the left of the display. Refer to Fig. 6–1. Always remove and replace the entire set of six batteries. Install the new batteries according to polarity markings next to the battery compartment. Replace the battery compartment cover and tighten the screws.

1.6 To install or replace the Receiver batteries, remove four screws from the battery compartment cover located on the bottom of the Receiver. Refer to Fig. 6–1. Remove all five batteries from the battery cavity. Install the new batteries according to polarity markings shown in the figure.

> ***WARNING***
>
> *Do not incinerate or mutilate the batteries. They may burst or release toxic materials.*

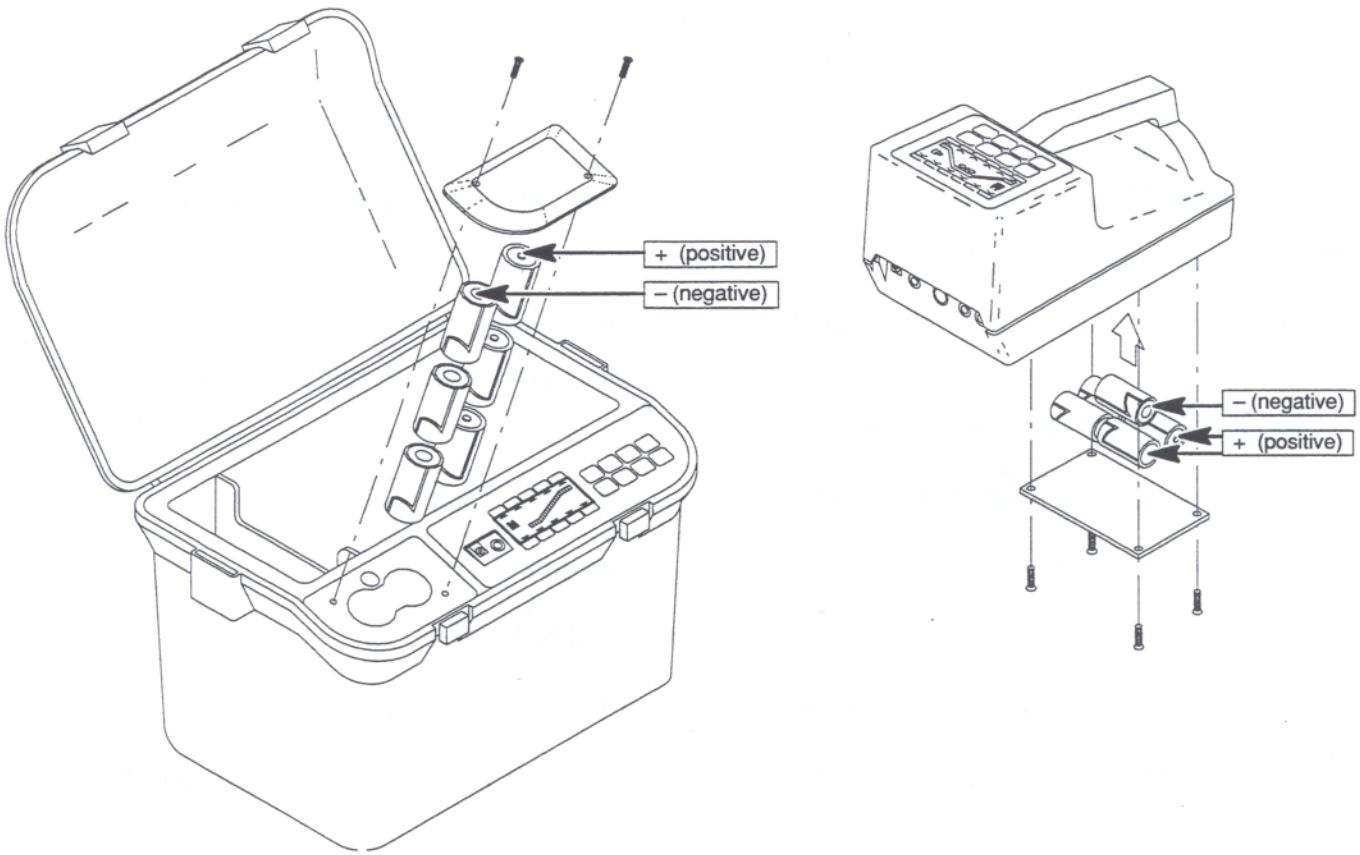

Fig. 6–1 Transmitter and Receiver Battery Replacement

C. Charging Ni-Cd Batteries

1.7 The Ni-Cd batteries may be charged using either the AC power supply or the 12-volt vehicle adapters (cigarette lighter cord or auto battery clip cord). The 'Y' cord is used for charging the Transmitter and the Receiver simultaneously. Refer to Fig. 6–2. All these devices are available as an optional accessory. The automobile adapters are fused with 2-amp fuses.

1.8 It takes about 15 hours to charge fully depleted batteries at room temperature. The charger can safely be connected for longer periods of time without harm to the unit or the batteries. To determine if the batteries need charging, observe the battery level indicator. When the indicator shows two segments, the job can be finished, but the batteries should be 'charged tonight'.

> ***WARNING***
> *Do not try to charge alkaline batteries. This could result in personal injury, explosion, or fire.*

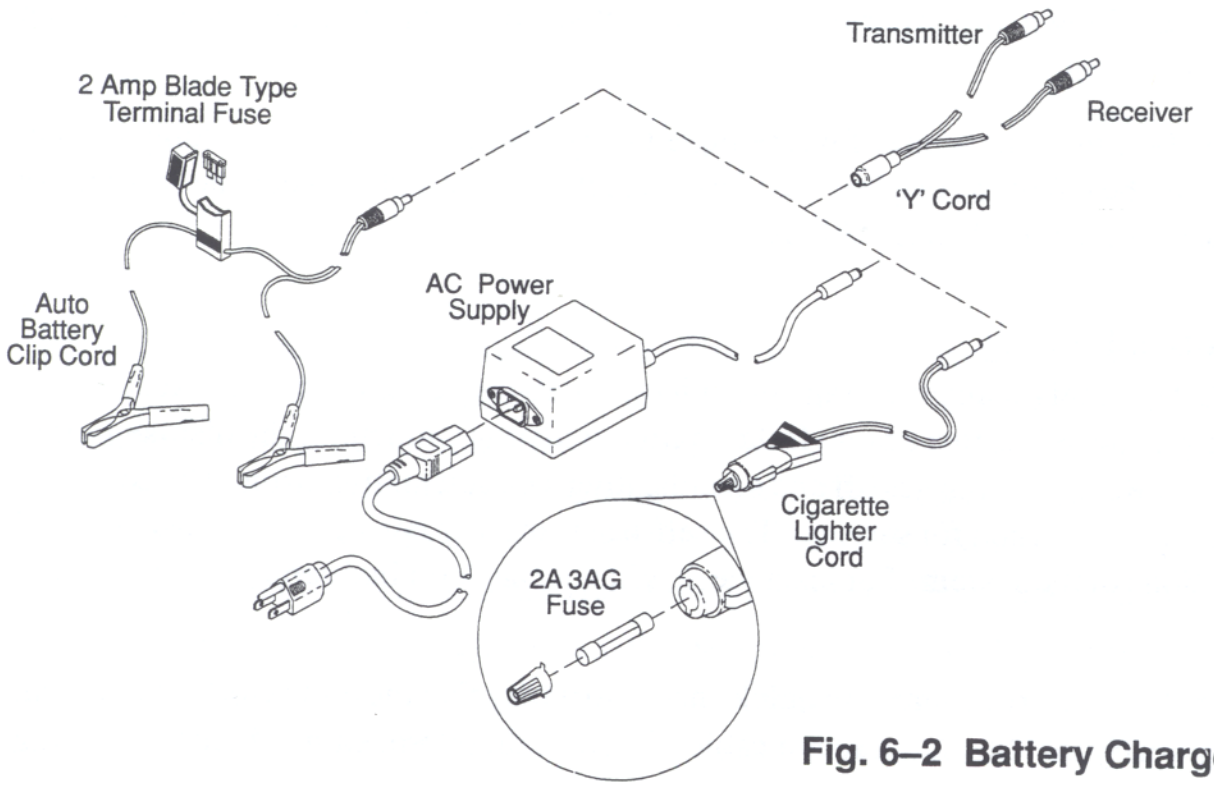

Fig. 6–2 Battery Charger

1.9 Do not attempt to charge batteries during excessively cold or excessively hot temperatures. The batteries either will not charge at all, or will not charge to full capacity. At high temperatures, Ni-Cd batteries do not work as efficiently. For example, at 45° C, Ni-Cd batteries cannot be charged to more than 70% of their capacity at room temperature. The charging time to this level is over 20 hours. Furthermore, excessive temperatures can damage batteries so that their life is shortened significantly. Cold temperatures hamper charging and a good battery could be discarded simply because it appears to not hold a charge.

D. Storage

1.10 To store the unit for long periods (greater than three months), remove the batteries from both the Transmitter and the Receiver. If the batteries are Ni-Cd, then charge fully before removing. Store the batteries at room temperature and low humidity. Upon re-installation of the Ni-Cd batteries (after storage), allow 2 or 3 charge/discharge cycles for full capacity to return.

E. Transmitter Fuse

1.11 The Transmitter batteries are fused to prevent their being drained in case of an electronic failure. The fuse also blows if batteries are installed incorrectly (backwards). When the fuse is blown, the batteries are disconnected from the rest of the Transmitter and it ceases to function.

1.12 To replace the Transmitter fuse, remove two screws from the battery compartment cover to the left of the display. The fuse is located above and between the two battery cavities. Replace with a 1-amp 3AG fuse.

F. Troubleshooting

1.13 Both the Receiver and the Transmitter have a self-test routine which is executed every time the unit is turned on. If the routine finds a malfunction, the display (either Transmitter or Receiver) flashes off and on indicating a circuit malfunction. The complete system should be returned for service. The self-test routine is not a comprehensive test of all the functions of the system. For instance, it will not check for bad cables or a bad antenna.

1.14 The following procedures are quick checks to verify that the units work as a system. They verify that the unit traces a cable. Perform these procedures before returning the unit for service.

a. Check that all batteries (both Transmitter and Receiver) are good. Check that the Transmitter fuse is good.

b. Check the continuity of all cables by connecting them in series. Plug the Dyna-Coupler cable into the Transmitter's ⇝ (input/output) jack. Connect the Direct Connect Cable into the Dyna-Coupler cable. Finally, connect the Ground Extension Cable to both clips of the Direct Connect Cable. Refer to Fig. 6–3. Press the Transmitter's [I/O] to turn the Transmitter on. Press [Ω] (ohms) and the Transmitter measures the resistance of the cable string. The bar graph should have every segment black (low resistance).

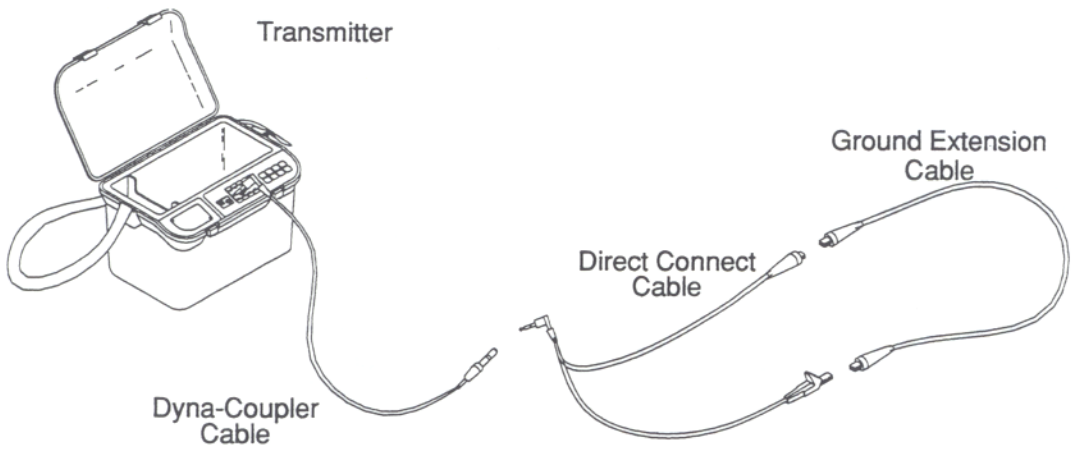

Fig. 6–3

c. Plug the Direct Connect Transmitter Cable into the Transmitter's ⇝ (input/output) jack. Connect the Black clip to the ground rod. Place the ground rod in the ground. Connect the Ground Extension Cable to the Red clip and lay it out on the ground in a straight line away from the ground rod. Place a screwdriver in the ground attached to the other clip of the Ground Extension Cable. Refer to Fig. 6–4. Press the Transmitter's [I/O] to turn the Transmitter on. Press [TRACE] (trace) and then [f Hz] to choose the lowest frequency. Look at the bar graph. It shows the relative amount of signal being fed to the cable (in this case the Ground Extension Cable). The signal level should be in the slanted portion of the graph indicating that the Transmitter is working.

d. Connect the Antenna to the Receiver using the Receiver-Antenna cable. Turn on the Receiver by pressing [⏻]. Select the trace mode by pressing [⚙]. Choose the ∧ (peak) mode. Press [f Hz] and select the same frequency as the Transmitter. Simulate tracing a buried cable by moving the antenna over the Ground Extension Cable. Find a peak which should be directly over the cable. At the peak, stop and press [✳] (gain). Find another peak and hold the Receiver so that the antenna is about one foot above the Ground Extension Cable. Press [📏] (depth) and check that the display reads the distance from the bottom of the antenna to the cable. Press [📏] (depth) to turn the depth function off. Choose the other trace modes and check that each finds the cable in the same place (not off to the side).

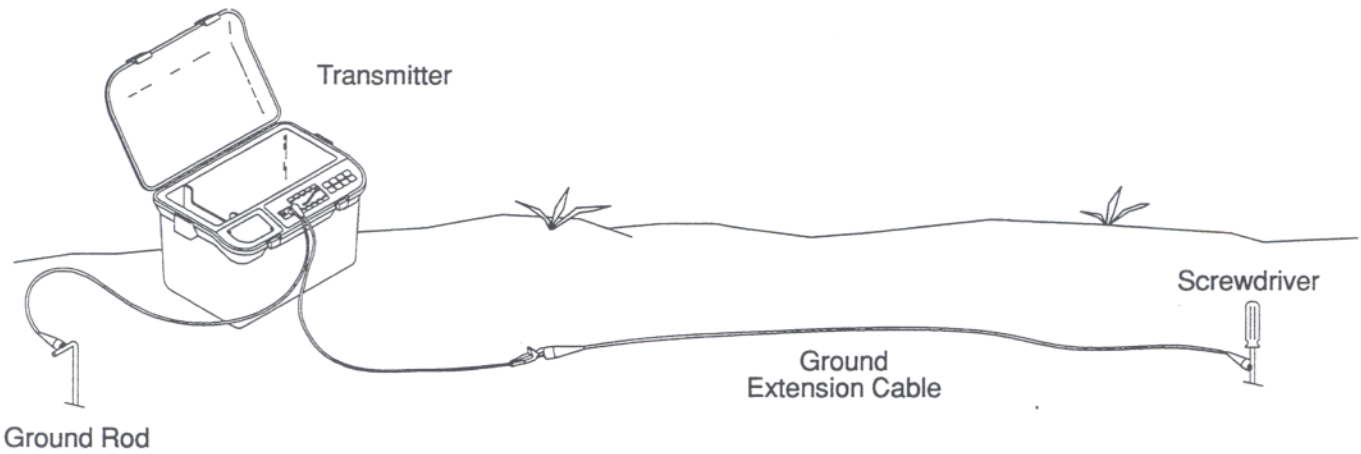

Fig. 6–4 Transmitter Test